GT GUIDE TECHNOLOGY INC.

GT200 UNIVERSAL COUNTER

OPERATING MANUAL

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GUIDE TECHNOLOGY INC.

GT200 UNIVERSAL COUNTER

OPERATING MANUAL

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CHAPTER 1
INSTALLATION

SYSTEM REQUIREMENTS

To install the GT200 Universal Counter board and software you must have the following equipment and software:

- IBM PC, XT, AT, or 100% compatible.
- PC-DOS or MS DOS Version 3.0 or above
- At least 512Kbytes of memory
- One floppy disk drive

BEFORE YOU START

Before you install your new GT200 Universal Counter make a backup copy of the GT200 Universal Counter Distribution diskette. Refer to your DOS manual for information on the FORMAT and DISKCOPY commands used to copy your diskette. Store the original diskette in a cool, dry place away from magnetic fields.

INSTALLATION INSTRUCTIONS

The installation instructions in this section provide a detailed description of the installation procedure. Please read the instructions in this section completely before attempting to install your GT200 Universal Counter.

The GT200 Universal Counter Distribution diskette which you received with the counter contains the programs for running the GT200, sample programs, and other utility programs. There is also a file named "README" that you should read first for additional information. You can display it on the screen by inserting the diskette in drive A and typing

type a:readme

The following files are necessary for running the counter:

- GT200.SYS - a device driver which is loaded into the machine when you turn it on or reboot
- VIRT.EXE - the Virtual Front Panel program

WARNING!

To install the GT200 Universal Counter board you have to remove the cover from your computer. For protection against electrical shock and to prevent the possibility of damage to your computer, ***never*** remove the cover without first ensuring that your computer is turned off ***and*** unpluged from the wall socket.

NOTE

Your host computer must be able to provide the following minimum power to the instrument:

+5 V at 0.8 Amp
-5 V at 0.05 Amp
+12 V at 0.2 Amp
-12 V at 0.02 Amp

Use the following procedure to install the GT200 Universal Counter board in your computer.

1. Remove the GT200 Universal Counter board from its packaging. Before handling the board, touch a grounded metal object such as the metal chassis of your computer to remove any static electricity which could damage the board. To ensure reliable operation, do not touch the gold contact fingers on the bottom edge of the board.

2. Set the base address DIP switch (SW1) on the GT200 board to the desired I/O address. See Figure 1-1 for location. The board occupies four addresses in the I/O address space of the host computer: the base address is the *starting address* for this space. The counter is shipped with the DIP switch set to the default I/O address "300 hex". If there is already a board using this address, a good alternative is "290 hex" (some LAN boards use "300 hex"). For your convenience, the diskette contains a program that displays the switch positions for any valid address. To run the program, place the "Distribution" diskette in drive A and type **a:sw1** and follow the instructions on the screen.

   The DIP switch address bits A2 through A9 are marked on the board. Sliding the tab "up" sets the switch to zero, sliding it "down" sets it to 1. See Figure 1-1.

   For example, to set the board to address 308 Hex (768 decimal) set the switches as follows:

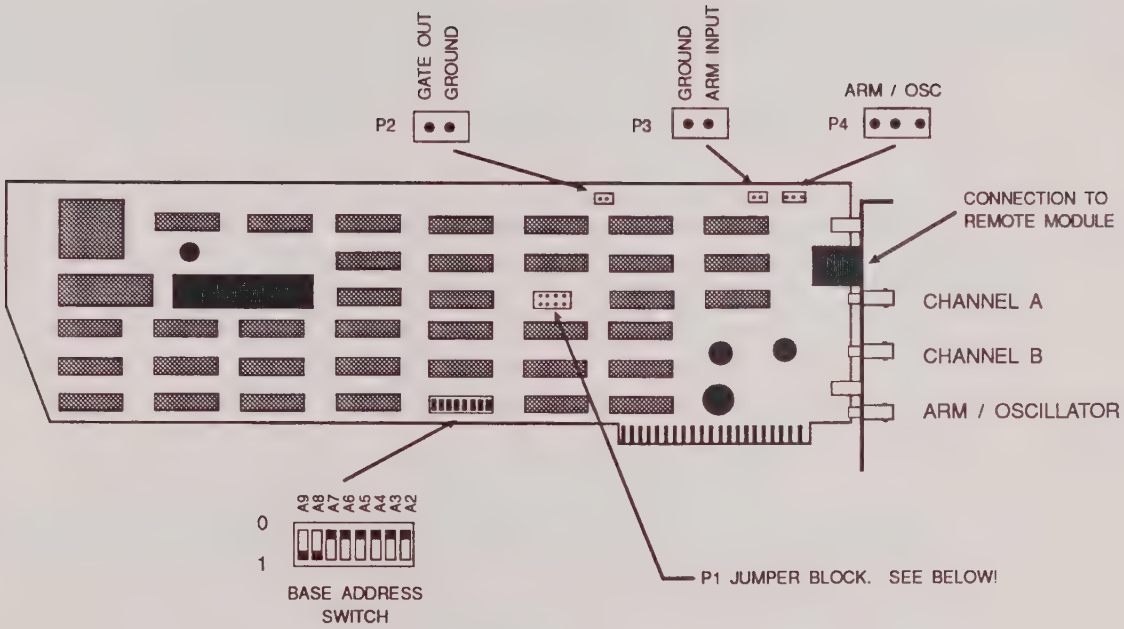
Address Line	A9	A8	A7	A6	A5	A4	A3	A2				
Switch Position	Down	Down	Up	Up	Up	Up	Down	Up				
Binary	0	0	1	1	0	0	0	0	1	0	0	0
Hex			**3**				**0**				**8**	

   The board will then occupy addresses 308 hex to 30B hex.

   If you are installing more than one board, the additional board(s) must be set to the next higher available addresses. For the example above, the second board must be set to address 30C hex , the third board to 310 hex, the fourth board to 314 hex, etc.

3. Turn off the power to your computer and unplug the power cord from the wall socket.

4. Refer to owner's manual for the host computer to obtain information on how to remove the computer cover.



P1. THE LOCATION OF THE SHUNT IS SET AT THE FACTORY. DO NOT MOVE!

P2. THE GATE OUTPUT SIGNAL IS AVAILABLE ON THIS CONNECTOR.

P3. THE AUXILIARY EXTERNAL ARM INPUT CONNECTOR.

P4. THE LOCATION OF THE SHUNT ON P4 DETERMINES THE SOURCE OF THE EXTERNAL ARM SIGNAL. SEE TABLE BELOW.

CHANNEL A / CHANNEL B BNC CONNECTORS. INPUT CONNECTORS FOR MEASURED SIGNALS.

ARM / OSCILLATOR BNC CONNECTOR. INPUT FOR EXTERNAL ARM AND/OR EXTERNAL OSCILLATOR SIGNALS.

SHUNT POSITION	CONNECTOR P3 FUNCTION	ARM/OSC BNC FUNCTION
	UNUSED	BOTH EXTERNAL ARM AND EXTERNAL OSC.
	EXTERNAL ARM INPUT	EXTERNAL OSC. INPUT

Figure 1-1.

Identification of User Accessible Connectors and Switches

5. There may be a bar over the computer's slots which holds the interface cards in place. If so, remove it.

6. Select a card slot for the GT200. Preference should be given to slots which are far from existing high power dissipation cards, such as expansion memory.

7. The GT200 must be installed so that the BNC connectors project through the rear panel of the host computer. The BNC connectors interfere with the computer rear frame if normal board installation is attempted. The rear (connector) end of the board should be tilted down, the connectors sliped under the top rail of the computer frame and the board aligned so that the BNC's project out of the rear panel slot. Next, line up the front of the board with the card guide and rotate the board so that it is horizontal.

8. Press the GT200 Universal Counter board firmly into the socket: check for proper alignment of the card edge connector if significant resistance is felt. Ensure that the BNC connectors are properly centered in the rear panel cut out.

9. Make certain that you reinstall the screw which secures the GT200 to the computer rear frame. This screw ensures proper electrical grounding of the card.

10. Slide the cover back onto the computer and reinstall the retaining screws.

11. Plug the power cord into the wall socket. Turn on the power.

12. If your system has a hard disk, copy the files GT200.SYS and VIRT.EXE to the hard disk. It is preferable to copy the files into a subdirectory, such as "GTI", which you can create with the DOS command "mkdir".

> **NOTE**
>
> If your system only has floppy drives, copy the GT200.SYS file into your boot diskette, and VIRT.EXE file to a working diskette.

13. Using any standard text editor, add this line to your CONFIG.SYS file:

DEVICE=d:path\GT200.SYS ADDR=<aaa> NUM=<nnn>

where,

d Identifies the drive being used.

path DOS directory path

GT200.SYS Identifies the filename of the driver

aaa Identifies the base address of the first GT200 board (board 0) in hex. All other GT200 boards must be set to consecutive addresses, spaced by four (e.g.., hex 308, 30C, 310....). The default is hex 300.

nnn Is the number of boards installed. Default is 1.

For example, if you have the GT200.SYS file in the the root directory of drive C:, the address is set at the default of 300H, and there is only one GT200 board, add the following line to the CONFIG.SYS file:

DEVICE=C:\GT200.SYS

If you have the GT200.SYS file in the directory \GTI of drive C:, the address is set to 308, and there are two GT200 boards (the second board would be set to address 30C hex), type the following

DEVICE=C:\GTI\GT200.SYS ADDR=308 NUM=2

14. If not already present, add the ANSI.SYS driver to your CONFIG.SYS file. The ANSI.SYS driver is supplied with DOS, and it is required for running programs that manipulate screen cursors. To have it loaded in your IBM host computer add the following line to the CONFIG.SYS file

DEVICE=d:path\ANSI.SYS

where,

d:path is the full directory path for the file

Also add the following line to your CONFIG.SYS file:

FILES=20

> **NOTE**
>
> To load the GT200 driver, reboot your host computer after you have changed the CONFIG.SYS file.
>
> The CONFIG.SYS file must be in your root directory, or on your boot diskette.

15. Reboot the computer.

> **NOTE**
>
> Watch the monitor during boot for a message from GT200.SYS. If the board(s) is found it will display the Guide Technology Copyright message and "GT200 Driver Installed".

16. Ensure that your mouse or other pointing device is operational.

17. Run the Virtual Front Panel application program to verify that you have properly installed the GT200 board(s). Change to the directory containing the VIRT.EXE file and type the following command to run the program.

virt <enter>

The sortware was correctly installed if the Virtual Front Panel graphic appears.

An error message may appear when you try to run "virt". Generally, this message indicates that the driver was unable to find the GT200 board at boot, and did not load. Please check that the address switches are correctly set on the GT200, that the config.sys file was correctly modified and that the driver is loaded in the correct directory. See sections 2 and 13 through 15, above. Note that the computer MUST be rebooted to load the driver.

Instrument operation can now be verified by entering the function menu and selecting CHECK mode. The Virtual Front Panel should display 10 MHz. Correct operation in CHECK indicates that the instrument card and the host are interacting correctly and that most of the instrument hardware is operational.

CHAPTER 2
DESCRIPTION OF FUNCTIONS

MEASUREMENT FUNCTIONS

This chapter describes the following GT200 functions and features:

- Frequency
- FastFreq
- Period
- Time Interval
- Time Interval with Delay
- Single Period
- Pulse Width
- Ratio
- Totalize
- Auto Trigger and Hold
- Arming
- Paced Measurements
- Acquire Mode (for high speed measurements)
- Statistics
- External Arm / External Oscillator Input
- Gate output
- User defined units
- Save/Recall setups
- Math (offset & normalize)

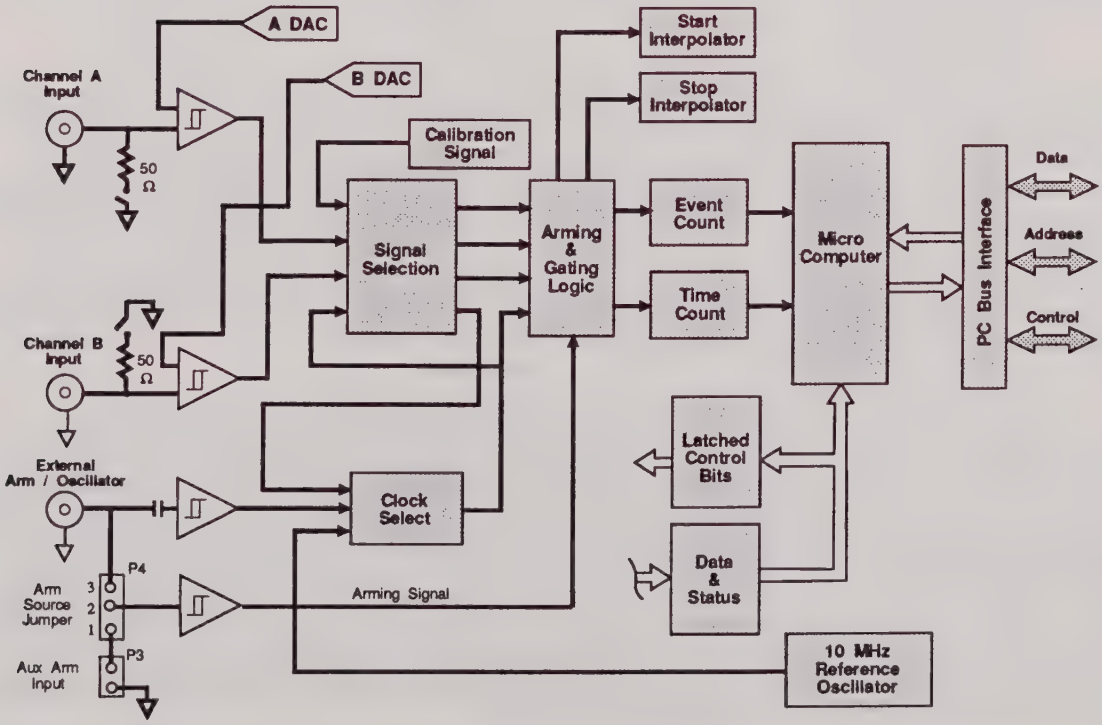


Figure 2-1. GT200 Block Diagram

Frequency

The GT200 measures input signal frequencies using the most accurate technique available, reciprocal counting coupled to time interpolation. There are two primary benefits of this method, improved accuracy and reduced measurement time. Fast measurements with high accuracy permit greater knowledge of the stability of a signal. For example, given a test frequency of 10KHz, a basic "direct count" counter will resolve 1Hz using a one second measurement time. In contrast, the GT200 can resolve 1/1000 Hz using a 1 millisecond measurement time. This measurement power allows the GT200 to compute the drift rate, mean, and peak to peak jitter of the signal, in the same time the conventional counter is simply measuring "Frequency".

Frequency can be measured on either of the two signal inputs, referred to as Channel A and Channel B. Channel swapping capability allows two signals to be monitored without moving cables or using a signal multiplexer. Signal frequencies can range from near DC to 100 MHz.

The user must specify the time span over which the signal frequency is to be measured. The measurement interval is traditionally referred to as the "gate time". Varying the gate time allows the user control over some measurement parameters. First, longer measurement times increase the number of significant digits in the result and increase the potential accuracy. Second, the gate time defines the averaging time of the measurement. A long gate time is useful if the AVERAGE frequency is of interest, while a series of measurements taken with short gate times can indicate the short term stability or jitter of the source. The GT200 allows the gate time to be set with digital accuracy over the range of 250 microseconds to 3200 seconds. The Virtual Front Panel gives 10 preselected choices, plus the ability to set any gate time using a dialog box.

Because of the measurement technique used, very low frequency signals will modify the actual measurement interval. In frequency mode, the minimum measurement time is one signal period: for example, it takes at least 100 milliseconds to measure a 10Hz signal, no matter how short the selected gate time. Furthermore, the measurement interval is quantized to an integral number of signal periods. For example, with a 10Hz signal and a gate time specification of 0.1 seconds, the actual measurement time could be either 0.1 or 0.2 seconds. The uncertainty can be eliminatedsimply by selecting a gate time where no ambiguity could exist: e.g. 0.01 seconds would ensure a one period measurement and 0.15 seconds would guarantee a 2 period measurement. Finally, there may be a significant dead time (up to 1 period) between initiation and the start of a measurement since that measurement must begin at a period boundary. These effects are mostly of concern to designers of computer controlled test systems, where unexpected variation in measurement time can cause confusion or malfunction.

When the input signal frequency exceeds about 1MHz, the signal is "prescaled" before being measured. Because the GT200 utilizes reciprocal counting measurement techniques, prescaling does NOT cause a reduction in resolution. The need for prescaling is determined just before each frequency or period measurement. There are some situations, however, where the user should explicitly turn prescaling "on" or "off". For example, during high speed data acquisition, the extra time required to automatically test the signal can reduce the maximum sample rate. Prescaling should be turned "OFF" if the signal will be less than 10 MHz and "ON" if it will be higher. It is also possible to fool the automatic selection process, if the signal frequency varies dramatically over the gate time. Manual selection, based on the maximum expected frequency, ensures correct operation. Note, that the only "problem" with prescaling is that a minimum of four signal periods must be measured: when the input signal is below about 10 KHz, prescaling could make gate times significantly longer than specified by the gate time.

If an application requires that frequency resolution and accuracy be maximized, care should be used in "conditioning" the input signals. Any noise (amplitude, frequency, or phase) associated with the signal will affect the measured stability. In fact, large amplitude "spikes" can produce totally erroneous results, providing they exceed the hysteresis of the input trigger circuits. If application problems are en-

countered, check the input signal carefully with a scope. A low pass filter can often eliminate false triggering due to impulse noise and reduce jitter caused by high frequency interference or broadband noise. "Ground" noise between the source and the counter can also contribute to increased measurement jitter: the solution is simply improved grounding or some method of isolating the signal grounds.

Some applications require that frequency measurements begin at very precisely defined times. This control can be provided by measurement arming: see the section titled ARMING for more information about Armed Frequency.

FastFrequency

A special "FastFrequency" mode is provided to allow frequency measurement using a very short measurement interval. (minimum gate time in the standard mode is 250 microseconds) The shorter measurement interval permits substantially faster data acquisition. In Fastfrequency, gate time is not a fixed interval, but a fixed number of signal periods: for hardware revision C, the number of periods is one, and for later revisions, it is four. The gate time setting is ignored. Measurement resolution for fastfrequency mode is best with low frequency signals, since resolution is proportional to the gate time (signal period).

Fastfrequency will allow the GT200 to acquire up to 2300 measurements in one second: standard frequency mode is limited to 1400 per second. Of even greater importance, fastfrequency allows the GT200 to be used for characterization of very rapid frequency transitions, as found in voltage controlled oscillators or phase locked loops. For more information on how to utilize this function, please request the appropriate Guide Technology application note.

Fastfrequency mode can be start armed: for more information, see the section on arming, below.

Time Interval

"Time Interval" is defined as the elapsed time between an event on the "start" input channel and an event on the "stop" input channel. An "event" can be defined through the "slope" controls, as either a positive or negative transition of the input signal.

Signal swapping allows the user to define either input channel as the start or stop. This function minimizes setup changes in bench top applications, and reduces the need for signal multiplexers in test systems.

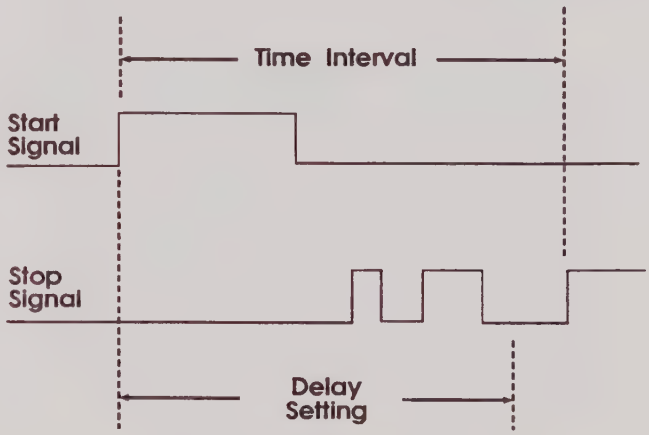
All timing functions utilize the time interpolation measurement technique, resulting in a single shot resolution of 100 picoseconds: this is equivalent to a conventional counter with a 10GHz clock rate. The term "single shot" means that only one measurement need be made: no averaging is necessary to achieve the stated resolution. Although averaging isn't required to provide high resolution, it can be used to reduce jitter caused by variations in the input interval and jitter caused by the measurement circuits. Note that the Virtual Front Panel Statistics mode allows measurement averaging without programming: it also provides a powerful method of characterizing pulse variation through the preprogrammed "max", "min" and "standard deviation" functions.

Time interval measurements can be both "start" armed and "stop" armed for maximum flexibility. See the section titled ARMING for more information.

Time Interval with Delay

Some time measurement situations are complicated by the presence of multiple "stop" events. For example, contact "bounce" can prevent an ill-equipped counter from measuring the pull-in time of a relay, since the interval will always end on the stop event generated by the first bounce. The GT200 can utilize a special mode to disable or "hold-off" measurement completion to ease such difficult measurement setups.

Although arming could be used to select the proper stop event, additional test equipment would be required. Time Interval with Delay mode provides the same capability through an internal, digitally generated, "hold-off". The duration of the hold-off is controlled by the user through a dialog box. A time interval with delay measurement begins like a standard measurement except that the stop event is disabled. As soon as the start event is recognized, the programmed delay begins. When the delay interval elapses, completion is enabled and the next stop event terminates the measurement.



Time Interval with Delay

On the GT200, the hold-off interval can be specified from 20 microseconds to 3200 seconds. Digital generation of the delay interval means that long delays will be very accurate; it also means, however, that the actual hold-off period can vary from one measurement to another by a few microseconds, due to clock synchronization uncertainty.

Period

The signal period is measured in exactly the same way as the signal frequency, described above. The period is simply the reciprocal of the frequency, since Period = 1/Frequency.

Single Period

Some applications require that the signal period be measured over exactly one cycle. In Single Period mode, the GT200 configures the internal measurement logic to perform a time interval. As in time interval mode, resolution is fixed at 100 picoseconds. Note that the specifications require a signal period greater than 25 nanoseconds for this mode.

Although the GT200 autocalibration process minimizes errors, single period will produce results which are less accurate than the conventional period mode. Period mode is superior since it averages errors over multiple signal cycles. For example, if a 1MHz signal (1 us period) is measured over a 1 second interval using Period mode, approximately 100 picoseconds error is distributed over 1 million events, for an average error of 100 attoseconds. However, in single period, approximately the same total error must be distributed over but a single event.

Ratio & AutoRatio

Ratio mode determines the ratio between the signal frequency on one input channel and the signal frequency on the second input channel. As in frequency mode, the measurement is performed during a user definable interval or gate time: longer gate times produce higher resolution results. Signal swapping allows the user to select a display of either A/B or B/A, depending on preference, without swapping cables and reconfiguring the input controls.

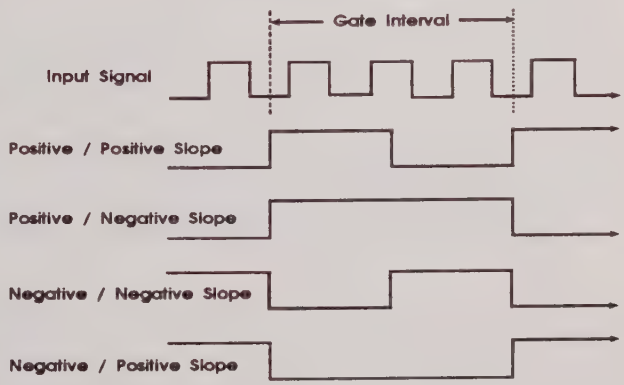
AutoRatio, a function unique to the GT200, removes the setup constraints and uncertainty commonly associated with this function, as implemented on other counters. The GT200 tests the input signals and automatically selects the internal connections which maximize resolution. If necessary, the measurement results are automatically converted to the format requested by the operator (e.g. A/B or B/A). (Other counters provide optimum performance only when the result is a ratio > 1.000)

Note that only one of the input signals may exceed 25 MHz in Ratio or AutoRatio modes. Furthermore, AutoRatio should not be used when signal frequencies drop below 400 Hz.

Totalize & Gated Totalize

The Totalize function allows events on one input channel to be counted for a period of time determined by either manual keyboard inputs, program statements, or events on the second input channel. In contrast to most other universal counters, the data is accurately reported on EVERY read command. On other counters, the +- 1 count accuracy specification applies only to data read out following gate closure, or at periods when no events are being accumulated.

For maximum flexibility, the GT200 provides three variations of the totalize mode. In the "manual" mode, a mouse click or program statement will explicitly open the count gate, close the count gate, or reset the count to zero. The manual mode provides the most convenient control of counting, but does not allow precise timing. The "gated" mode allows a second input signal to open and close the gate on user specified signal transitions. After the gate closes, the measurement data is held until explicitly reset by the user or by a program statement.



Gated Totalize -- Slope Selections

The gating interval for gated totalize mode is defined by the "Gated Tot Slopes" entries of the Inputs menu. Selecting like slopes for the start and stop (e.g. both positive) sets the gating interval to one period of the gating signal. Setting opposite slopes for start and stop changes the gating interval to a pulse width of the gating signal.

In some applications, it is desirable to keep a running total count over multiple gate intervals: this capability is provided by the Accumulate mode. Accumulate mode, like Gated Totalize, allows an external signal to determine the gate interval. The count gate, however, can be opened and closed an indefinite number of times. Less than 0.5 microsecond of "deadtime" is required between the closing of one gate interval and the beginning of the next. Data can be accurately read at any time.

Pulse Width

"Pulse Width" provides a convenient way to automatically set-up the GT200 for this common measurement. The pulse polarity (i.e. positive or negative) is defined by the slope selection, found in the "Inputs" menu, for the specified channel. For example, to measure the width of a negative going pulse on Channel B, select Pulse Width B in the Function menu, and Channel B slope Neg in the Inputs menu. Measurement resolution, as in other time interval modes, is 100 picoseconds. The threshold levels can be set either by the auto trigger function or explicitly.

Auto Trigger

The auto trigger function automatically sets the input comparator trigger levels just before EACH measurement. The GT200 first determines the positive and negative peak levels applied to the active input channels and then sets the trigger level voltages approximately midway between the measured peaks. This process takes approximately 50 to 250 milliseconds, depending on signal amplitude and frequency.

Although Auto Trigger is a very convenient feature, there are some situations where its use is inappropriate. Consequently, both the virtual front panel and the command language allow Auto Trigger to be disabled and the levels to be set explicitly. For example, auto trigger limits the maximum measurement rate to about 20 per second, even in acquire mode. When faster rates are needed, auto trigger must be disabled. (see the discussion of the Hold function, below.) Second, Auto Trigger will not operate reliably when the input signal repetition rate falls below 100 Hz. Although the basic algorithm could be extended to lower frequencies, the time required for ALL Auto Trigger operations would increase. Finally, it is inappropriate to use Auto Trigger in any measurement where signal amplitude can vary periodically, as in pulsed RF.

The "Hold" feature brings the benefits of auto trigger to most of the applications which should not use it, such as totalize and high speed data acquisition. Trigger level "hold" retains the last auto trigger setting until the feature is turned off.

Auto Trigger operation follows these steps in most measurement modes:

1. Measure signal positive and negative peak levels.

2. Trigger level set half-way between positive and negative peaks.

3. Wait 0.5 second for measurement to start. If the measurement does not start, reset and return to step 1.

4. If the signal is lost after the start of a measurement (frequency is less than 2Hz) reset and return to step 1.

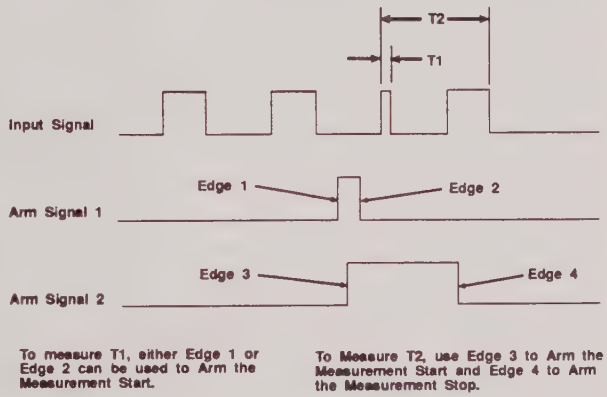
5. Complete measurement and return to step 1.

Steps 3 and 4 prevent the instrument from "hanging up" if the signal changes amplitude or is disconnected. Note that step 4 is skipped in Time Interval mode, since the actual measurement time is unknown. If the signal level changes during a measurement and a time interval "hangs up" , click the reset button on the virtual front panel. All test programs using ANY timer/counter should have "time-out" facilities to prevent infinite wait states such as this.

Arming

Some time interval measurements, such as circuit propagation delay, are easy to set up. Other measurements can be more challenging, especially if the signal is not perfectly repetitive: in fact every event may be unique. Measurement arming is a significant aid, since it creates a "time window", explicitly selecting specific events. Arming is especially valuable in test systems, since it ensures valid results on every measurement. The arming window is defined by events (signal transitions) applied to the GT200 External Arm input.

Two modes of armed operation are possible: Start Arm, and Start plus Stop Arm. In the start arm mode, the arm input event opens the time window and the next start event initiates the measurement. The FIRST stop event following the start will terminate the measurement. Sometimes, it is desirable to "skip" stop events: for example when the delay from the first to the fifth pulse must be measured. Start plus stop arm allows the stop event to be selected as well as the start event. In many cases an appropriate arming signal can be found in the circuit under test: if this is not the case, either external equipment or dedicated circuitry must be used. Some useful external tools for generating the arming signals are pulse generators and oscilloscopes. Pulse generators can provide appropriately delayed signals of variable width to facilitate both arming modes. Some oscilloscopes can provide an easily positioned arm signal from their delayed gate output. The input signal is routed to both the scope and the GT200 and the delayed gate output is connected to the GT200 External Arm input: the scope delay controls are then adjusted to "highlight" the appropriate portion of the signal. This technique is especially beneficial since the arm window is visible and can be precisely adjusted to select the desired event.


T2
T1
Input Signal
Edge 1
Edge 2
Arm Signal 1
Edge 3
Edge 4
Arm Signal 2
To measure T1, either Edge 1 or Edge 2 can be used to Arm the Measurement Start.
To Measure T2, use Edge 3 to Arm the Measurement Start and Edge 4 to Arm the Measurement Stop.

SIGNAL ARMING

Frequency and period modes (including FastFrequency) can be armed for precise control over the measurement interval starting point. This is especially useful if the signal to be measured is a burst signal or it is frequency modulated. Although armed frequency allows the beginning of the gate interval to be defined, the end of the measurement interval is defined by the specified gate time; it cannot be set by the arming signal.

Paced Measurements & Single Measurement

The GT200 features a Pace mode which ensures the acquisition of data at accurately spaced time intervals. In Paced operation, the user specifies the time which should elapse BETWEEN the initiation of measurements. The pace times are digitally generated on the GT200 board, and are accurate to within 200 uS (the errors do not accumulate). The intervals can be set from less than one millisecond to more than 3200 seconds (the minimum pace interval is 0.8 mS for Time Interval and 1.0 mS for Frequency and Period). See the FREQUENCY section for timing ambiguities which can occur if the signal has a low repetition rate. The shorter intervals allow the GT200 to operate much like a frequency domain, digital sampling oscilloscope, while the longer intervals allow unattended acquisition of slowly changing data.

Pacing is controlled by selections in the Arm menu. Intervals are specified through a dialog box, while another menu item determines how paced data acquisition begins (see below).

Some care must be used when selecting pacing intervals to ensure consistent timing between samples. The pacing interval must be at least 600 uS longer than the actual gate time in Frequency and Period modes, or 600 uS longer than the actual measurement interval in timing modes, such as Pulse Width. If these recommendations are not followed, the counter will simply "skip" measurements, and the data will be taken at uneven intervals. If skipping occurs in Acquire mode, a "Pace Overrun" warning appears on the Virtual Front Panel (clear the warning with a Reset).

In many situations it is advantageous to synchronize the start of data acquisition to a stimulus signal. The GT200 allows a signal applied to the External Arm input to initiate a block of paced measurements. For convenience, either a positive or negative slope can be selected as the trigger event. When triggered mode is disabled, pacing is initiated immediately after a setup or reset. For example, the GT200 can be used to determine the frequency versus time performance of a VCO (voltage controlled oscillator). Triggered pacing allows the counter to wait until the arrival of the stimulus pulse before beginning acquisition. The interesting data will then be located in a consistent portion of the output file. Note that the large data memory of the GT200 allows it to capture events which cannot be acquired synchronously using triggered pacing. Even at the maximum sampling rate of the counter, a 640K PC can acquire more that 20 seconds worth of data. The resulting output file can be compressed by removing superfluous data.

The "single" mode halts display update after a single measurement is made. This feature is useful when results must be recorded manually, or when a high resolution result must be checked carefully.

Acquire Mode (for high speed measurements)

Acquire mode allows the GT200 to make a block of measurements and place the data in a user specified array in memory. This strategy increases maximum measurement rate by eliminating the time overhead required to communicate results back to the application program through DOS. Upon completion of the data block, results can be transferred to a user specified file using the "Save to File" menu selection. In non-acquire mode, the GT200 can return about 400 measurements per second, but the rate is dependant on the "speed" of the host PC. In acquire mode, the sample rate is substantially higher, and is independent of host performance. About 2300 measurements per second in Time and FastFrequency and up to 1400 measurements per second in Frequency and Period can be made. Pacing is also available during acquire, to ensure even measurement spacing. Pacing, however, reduces the maximum acquisition rate to less than 1250 measurements per second. See the section on Paced Measurements and Chapter 5..

The maximum length data block a PC can acquire is a function of its memory size. Eight bytes of main memory are used to store a single measurement result, so a 640K computer can acquire blocks larger than 50,000 measurements.

Note that the data block generated by the acquire mode will be fully computed and calibrated. When operated at comparable data rates, even very expensive GP-IB counters return "binary" data. The computation and calibration are left up to the user's application program.

Statistics

With the Statistics mode, the GT200 can automatically acquire measurement data without the need for an application program. The available functions are

- Mean of sample block
- Standard Deviation of sample block
- Minimum and Maximum measurements in a sample block

Standard Deviation is especially useful for estimating the stability of signals. A low standard deviation indicates that the signal is stable and exhibits a low measurement to measurement jitter. Alternatively, the Min and Max functions simplify limit checking to ensure that a source does not have excessive peak deviation. Min and Max can also be used to calculate the peak deviation of a frequency modulated signal, replacing very expensive modulation analyzers or deviation meters.

Two operating strategies are available in Statistics mode, "Continuous" and "Acquire". In Continuous operation, the four parameters are computed after each data sample, and the display is updated. Although this mode runs more slowly than Acquire, it allows a running check of the selected parameters; furthermore sample size is unlimited. In a typical application, continuous display would be used to search for an infrequently occuring error condition in a digital circuit: the setup would be left operating for long periods, while the counter captured and held the peak data points. The second strategy uses the Acquire mode to gather blocks of data: the statistics parameters are computed following acquisition. The advantage of the block method is that data can be collected at up to 2300 measurements per second since the data is post-processed. The size of the data block is user programmable from a dialog box in the Virtual Front Panel. Pacing may be used during the data acquisition.

A useful enhancement of "Acquire" mode is the auto-restart option. Auto-restart allows the GT200 to alternately acquire and then compute statistics results for an indefinite period. For small sample sizes and short measurements, the display is updated quite rapidly.

Note that the statistics Acquire mode can appear to "hang-up" if the counter is not set up properly. The most common reason is that Auto Trigger was left enabled, slowing data collection to just a few samples per second.

External Arm & Oscillator Input

The third signal input on the GT200 combines the functions of an external arm signal input and an external oscillator input. Although the Arm/Oscillator input port is shared, the internal circuits are completely separate (see Fig. 2-1). Both functions employ high speed comparators, with hysteresis, to provide signal conditioning. The arm function is DC coupled and requires TTL level signals: i.e. the threshold voltage is approximately 1.4v. The oscillator function is AC coupled, and requires at least 100 mv rms of signal amplitude (300 mv peak to peak). Note that the external oscillator frequency must be within 10% of 10 MHz, or the internal circuits may malfunction, reducing resolution.

If both external arming and an external oscillator are required simultaneously, either of two strategies can be used. The first works only for single channel functions, such as frequency and period. The second ("alternate") input channel, can be used as the reference signal source. This selection is available both from the virtual front panel and the command language, and frees the Arm/Oscillator port for exclusive use as the arm input.

The second way of separating the functions requires changing jumpers on the GT200, plus the creation of a new rear panel with a fourth BNC connector. Please check with Guide Technology about the availability of a factory packaged kit. See Fig. 1-1 for the location and position of the jumper. The steps to follow are:

1. Move shorting jumper on block P4 from the center and right-most pins to the center and leftmost pins. This makes the Arm/Oscillator input only work as an external reference input.

2. Create a new rear panel for the fourth (Arm) BNC.

3. Connect the arm signal to block P3 using appropriate push-on connectors. Note that the ground should be connected to the left-most pin, as noted on the PC board.

Gate Output

In some situations it is advantageous to know exactly when the GT200 measurement gate opens and closes. Applications would include debugging a setup in which arming is used or to verify input comparator trigger points. The "gate out" signal is available on the GT200 board from the two-pin connector P2. A scope probe may be clipped onto the connector pins, or a two wire cable can be built and plugged onto the connector. The output is TTL level, with a 100 ohm series resistor. This combination can drive a 50 ohm cable and 50 ohm termination, delivering about 0.8 v peak to peak to the load.

The "gate out" signal is a TTL "high" during the gate interval, and low at other times. Several of the automatic functions available on the GT200 can cause spurious "gate out" signals just before the expected gate. If the gate events generated by auto trigger, auto calibration and auto prescale cause a problem, they can be explicitly disabled. For example, spurious gate events may cause a scope to trigger erratically, or may prematurely trigger another instrument.

An example application for the "gate out" signal would be to use it to arm a second GT200. Two counters could be used to acquire sequential measurements on a complex signal. The first GT200 would acquire a data point and arm the second: the second counter could then immediately capture a related signal transition. The counters could be interconnected with a simple two-wire cable.

Save/Recall Setup

The Save Setup and Recall Setup selections in the Math/Other menu allow a complete instrument "state" to be stored and later recalled. This capability is especially useful for more complicated setups, or when a number of setups must be made over and over again. A special file allows the GT200 to "power-up" in a specific state, other than the normal "default" state.

After electing to save the current instrument state, a destination file name must be entered into a dialog box. Any name and extension can be specified, within the guidelines set by DOS.

There is one file name reserved for the Virtual Front Panel power-up state, "auto200.set". This state will be automatically restored whenever the front panel application program is started.

Note that the "init" (initialize) command or menu selection places the GT200 in the standard default state.

Math

The "Math" functions, found in the Virtual Front Panel "Math/Other" menu, allow the GT200 to offset and normalize the measurement data before display. There are many uses for mathematical data manipulation:

1. Calibration. The user can externally calibrate the system and enter the factors into the math function.
2. Units conversion. Counters are often used to monitor transducers which generate a frequency output proportional to some parameter. Math functions allow the front panel to directly display the parameter value. Some example transducers which generate frequency output are: flow meters, quartz temperature sensors and quartz pressure probes.
3. Operator convenience. Counters are often used to monitor an electrical parameter while an adjustment is being performed. The math functions can convert a complex numerical result into more easily understood terms, such as percent deviation.
4. Drift testing. The initial value of the measured parameter can used as an offset factor. The display will then report the deviation, rather than the absolute magnitude of the parameter.

The available math functions are offset and normalize. The general equation solved by the GT200 is simply:

Display = [Measurement results/normalize] + offset

Note that the offset is an additive factor: to "zero" the display enter the offset as a negative number.

Some applications call for slight variations on this equation. For example, in precision oscillator testing, the deviation from an initial reading, in parts-per-million, is usually desired. To produce that display, the following parameters would be entered:

normalize factor = nominal frequency / 1e6
offset factor = - 1e6

User Defined Units

The GT200 can be used in a number of applications where the Virtual Front Panel display will represent some parameter other than the measured parameter. For example, the GT200 could monitor the output of a flow meter whose output frequency is proportional to flow rate. The flow meter calibration constants could be entered into the math function so that output would read directly in gallons per minute. User defined units allows the units (e.g. Hz or seconds) to be replaced by more appropriate units (e.g. GPM).

Any three characters, including those from the IBM Extended Character Set, can be substituted for the normally displayed units. User defined units is selected in the Math/Other menu; the specific characters are entered in a dialog box which appears after selection. The units are saved along with the other setups, in the instrument setup files.

The Extended Character Set can be selected by entering the appropriate 3 digit code while holding the ALT key down (on most keyboards, the numeric keypad must be used). For example, if you want the units to be a capital "Omega", enter ALT-234. Some of the codes, such as ALT-003 (control-C), may cause unexpected results, so be careful. See your DOS manual for other special symbols.

CHAPTER 3
VIRTUAL FRONT PANEL OPERATION

THE VIRTUAL FRONT PANEL

The Virtual Front Panel allows the GT200 to be used just like a bench-top instrument, except functions are selected by a mouse, rather than buttons. The Virtual Front Panel is an application program (VIRT.EXE) which runs under DOS 3.0 or higher. Remember that VIRT.EXE also uses a device driver program which must be loaded into the computer at boot. See Chapter 1 for driver installation instructions. See Chapter 4 for information about operating the GT200 from an application program.

Starting the Virtual Front Panel program

- Start VIRT.EXE like you would any other application program e.g. at the DOS prompt, type VIRT and then press the ENTER key.

Virtual Front Panel program options

- The front panel will look better on some monochrome monitors if the program is started with the /MONO option. e.g. type VIRT /MONO. This option will also force monochrome operation on color monitors.
- The /COLOR option will force operation in color mode only e.g. VIRT /COLOR.
- In systems that contain more than one GT200, the Virtual Front Panel must be told which instrument it should control with the /Sx option (x = the board identification number. Numbering starts at 0). For example, VIRT /S1 would use the second board installed by CONFIG.SYS.

Using the Virtual Front Panel

The Virtual Front Panel is controlled by either a Microsoft mouse compatible pointing device or the standard keyboard.

- **Using a Mouse**

  Position the cursor over the desired menu selection and click the LEFT button. Some menu items have two selection areas: one selects the function and the other invokes a dialog box for data entry. The data in a dialog box is accepted when the left mouse button is clicked or the ENTER key is pressed.

  Most of the menu items can be selected by clicking on adjacent portions of the menu area. Experimentation will demonstrate the required cursor placement accuracy.

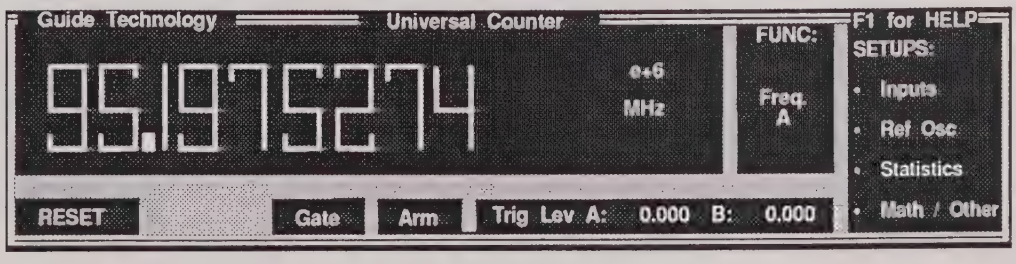


Figure 1. Virtual Front Panel

To exit a menu, either click the right mouse button or select the "Exit Menu" item with the left mouse button..

- ## Using a Keyboard

Although mouse control is quicker and more intuitive, cursor position can also be controlled with the keyboard "arrow" keys. Menu items are selected by placing the cursor over the item, and pressing the "ENTER" key (equivalent to clicking the LEFT mouse button). A menu is exited by pressing the "ESC" key (equivalent to the RIGHT mouse button).

- ## Operation

The top level menu, shown in Figure 1, allows access to several groups of related functions, arranged in pull-down menus. The pull-down menus are activated by selecting the desired keyword with the mouse. Additionally, there are two control "buttons" which produce an immediate action: RESET and START/STOP. The START/STOP button appears next to the RESET button when some functions are activated. The label on the button changes to indicate the effect it will have when NEXT invoked.

Some secondary measurement information (e.g. measurement count), as well as error and warning messages can appear on the panel between the main display area and the bottom row of controls.

Each of the pull down menus has an associated HELP screen, which can be accessed by the mouse. The information contained in these screens can resolve most questions about instrument operation.

The Virtual Front Panel occupies 1/3 of the monitor display area, allowing sufficient room for two other PC instrument front panels. Although an application program can utilize multiple GT200 counters operating on the same computer, the Virtual Front Panel will control only one. The Virtual Front Panel will appear in color on monitors so equipped.

The Virtual Front Panel program should be terminated via the "Exit Prog" menu selection, located under "Math/Other". The program can also be terminated by a <ctrl-C>, although this is NOT a recommended procedure because it prevents the program from "cleaning up" before exit. Also available is a temporary Exit to DOS. Accessing DOS without terminating the program allows the operator to run other programs, graph data or inspect data files without losing the setup and prevents repeated program reloads. The Virtual Front Panel is restarted by entering "exit" at the DOS prompt. Remember that "VIRT.EXE" is still resident, so memory is reduced.

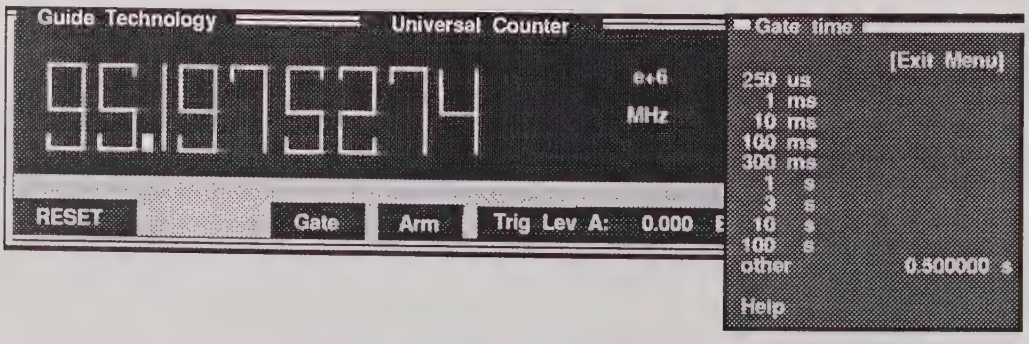


Figure 2. Gate Time Menu

VIRTUAL FRONT PANEL FUNCTIONS

RESET

RESET clears the output data buffer, starts a new measurement, clears the count in Totalize and Accumulate, clears errors and removes error messages

RESET does not change the instrument setup.

To place the instrument in the default state, see INIT.

GATE

- **250 uS, 1 mS, 10 mS, ... 100 S**

  See Figure 2. Nine preprogrammed gate times are available and can be quickly selected with the mouse. For Frequency, Period, Ratio and Check functions, the selected Gate Time sets the minimum measurement interval. The Gate Time is ignored in all other modes.

- **Other**

  This selection opens a dialog box and allows the entry of any gate time within the specified range. Gate Times may be set with a resolution of 0.75 uS, over the range of 250 uS to 3200 seconds. The entered value will be retained by a setup "Save".

ARM/CYCLE

The selections in this menu control ***when*** measurements are made e.g. PACING selects the time between measurements and ARMING allows external signals to control measurement initiation. See Figure 3.

Cycling Mode

Selections specify how frequently unarmed measurements should be made.

- **Normal**
  Instrument measures continuously.

- **Single**
  Instrument makes a single measurement and displays the result continuously. RESET clears the last measurement from the display and initiates a new measurement.

- **Paced**
  Selecting the top portion of the menu item turns pacing on (Pacing accurately controls the spacing between measurements - see page 2-7). The current pacing interval is shown in the associated window.

  ·A new pacing interval can be entered by selecting the lower (numeric) portion of the "Paced" area to open a dialog box. The interval can be set with a resolution of 0.75 uS, over the range of 0.8 mS to 3200 seconds. **The pace interval must be at least 600 uS greater than the measurement time**.

Pace Start

The initiation of paced operation can be triggered to synchronize data acquisition to external events. The following three selections specify the trigger event. **All measurements, except the first, are controlled by the pacing specification.**

- **Internal**

  Pacing begins immediately after selection or after a RESET.

- **External Positive**

  Pacing is initiated by the first positive edge applied to the ARM/OSC input. RESET halts pacing and returns the GT200 to a "waiting for trigger" state.

- **External Negative**

  Pacing is initiated by the first negative edge applied to the ARM/OSC input. RESET halts pacing and returns the GT200 to a "waiting for trigger" state.

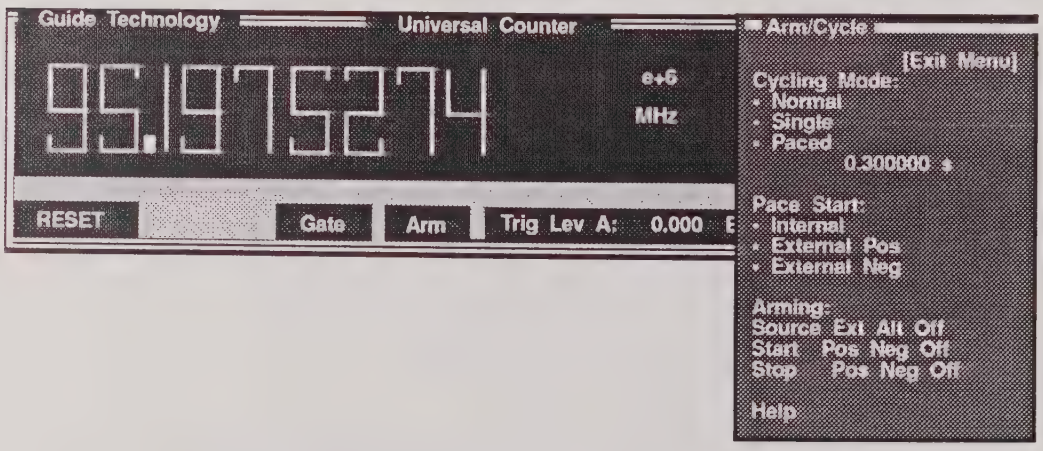


Figure 3. Arm/Cycle Menu

Arming

Arming mode has the following RESTRICTIONS:

Frequency, Period, Ratio, FastFreq, Ti-Del ----- Only Start Arm is available

TI, Sper, Width ----- Both Start and Stop Arm are available.

Tot, Accumulate, Check ----- No arming is available.

The following selections provide complete control over "arming" of individual measurements.

Source

Defines the input port which will be recognized as the arming signal.

- **External** The External Arm Input
- **Alternate** The Alternate input channel for single channel measurements like Freq.
- **Off** Turns off arming. Measurements are armed internal to the GT200.

Start

Selects the Arm signal slope which enables the initiation of the measurement.

- **Positive** Positive signal transition
- **Negative** Negative signal transition
- **Off** Disables start arming

Stop

Selects the Arm signal slope which enables the conclusion of the measurement.

- **Positive** Positive signal transition
- **Negative** Negative signal transition
- **Off** Disables start arming

TRIGGER LEVEL

See Figure 4. The "Trigger Level" setting defines the input signal voltage that creates a logical event from the input comparator circuit (trigger level is also commonly known as "threshold" voltage). The trigger level can be set anywhere between +5 V and -5 V, with 0.040 V resolution. User entered values are rounded to the nearest least significant bit.

The level specifications for Channel A and Channel B are independent.

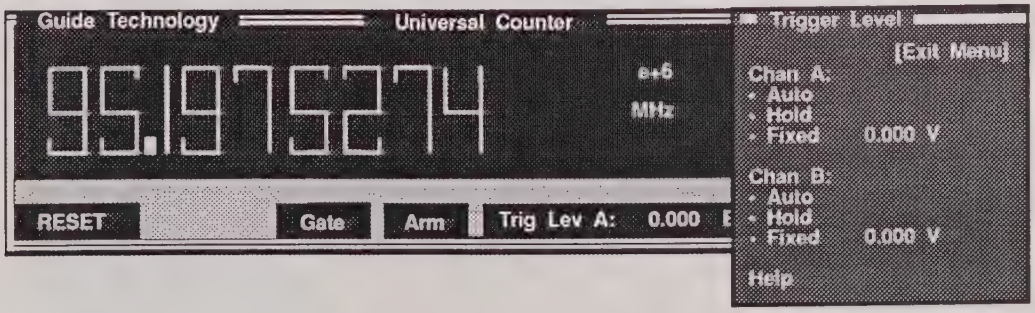


Figure 4. Trigger Level Menu

- **Auto**

  In auto trigger mode, the board evaluates the peak input signal levels just before each measurement. The trigger levels are then automatically set to the approximate signal midpoint. Auto trigger may add up to 250 ms. **per measurement** and is specified only for signal frequencies above 100 Hz. Auto trigger and Hold can be used together to provide most of the benefits of auto trigger without excessive measurement time.

- **Hold**

  The Hold function maintains the trigger level setting active when it was invoked. The primary application for "Hold" is to maintain an auto trigger set threshold over a number of measurements, without incuring the auto trigger time penalty on each measurement.

- **Fixed**

  Selecting the "Fixed" portion of the line, sets the trigger level to the value displayed in the numeric window. Selecting the numeric window opens a dialog box, allowing entry of any fixed level between +5 V and -5 V.

FUNCTION SELECT

This menu is used to select both the measurement function and the input channel allocation. Setups are made by clicking on the intersection of rows (functions) and columns (channel configurations).

All functions permit "channel swapping" (i.e. Time Interval can be measured from A -> B or B -> A). This feature simplifies cable assignment and reduces the need for signal multiplexers in test systems.

Most functions begin operation as soon as they are selected (assuming that other selections permit). The totalize function, however, is selected with the gate "closed". The gate is controlled by the "start" and "stop" buttons, which appear after selection of the function.

- **Frequency** (Freq)

  Normal Frequency measurement mode (gate time is selected in the Gate menu). Measurement resolution in this mode is superior to that in FastFrequency.

Figure 5. Function Select Menu

- **FastFrequnecy (FastFreq)**

  Frequency measurement mode in which the gate time is equal to 4 signal periods. Use the function when measurement time must be minimized.

- **Period (Per)**

  The Period function is identical to Frequency, except the result is mathematically inverted before display.

- **Time Interval (TI)**

  TI measures the time between an event on one input channel and an event on the second channel.

- **Time Interval with Delay (TI-Del)**

  Like Time Interval, TI Del measures the time between events on the selected channels. However, the "stop" channel is disabled until a preset time delay has elapsed. When this function is selected, a highlighted numeric window appears at the bottom of the menu. The number which appears in the window is the current delay interval. Selecting the numeric window will open a dialog box allowing entry of a new interval. The delay may be set with a resolution of 0.75 uS, over the range of 20 uS to 3200 seconds.

- **Single Period (SPer)**

  This function is used to measure period over exactly one cycle of the input signal. Both resolution and bandwidth are inferior to the standard period mode.

- **Width**

  This function measures the pulse width of the selected input signal. The pulse polarity is controlled by the input channel slope specification located in the "Inputs" menu. For example, to measure the negative pulse width (falling edge to rising edge) on Channel B, set the Channel B slope to Neg.

- **Ratio**

  This function measures the ratio between the frequency of one input signal and the frequency of a second input signal.

  Only one of the input signals can exceed 25 MHz. For highest accuracy, connect the higher frequency to the channel shown in the table below:

	Ratio A/B	Ratio B/A
Both inputs < 25 MHz	B	A
One input > 25 MHz	A	B

- **AutoRatio**

  AutoRatio maximizes measurement resolution and convenience by automating signal routing within the counter.

  If one or both of the input signals is less than 400 Hz, use the standard Ratio mode.

- **Totalize (Tot)**

  Totalize mode counts the events applied to the selected input channel between the START and STOP commands. START and STOP commands are issued by the START/STOP button on the Virtual Front Panel. The RESET button also clears the count.

- **Gated Totalize (Tot A by B Tot B by A)**

  Counts the events applied to one input channel during an interval defined by a signal on the second channel. The first channel in the specification is the count channel, and the second is the control or gating channel.

  A special menu is available under "Inputs" to specify the signal slopes for the start edge and the stop edge on the gating channel. See the appropriate section of Chapter 2 for more complete information.

  A single gate cycle is measured and displayed. Another measurement will be taken after each reset.

- **Accumulate (Accum A by B Accum B by A)**

  Accumulate is a special variation of Totalize A gated by B, in which the gate is reenabled immediately (<0.5 usec.) after closing. The next event on the gating channel will reopen the gate.

  The gate can be cycled indefinitely. The count will continue to accumulate unless explicitly RESET.

  A special menu is available under "Inputs" to specify the signal slopes for the start edge and the stop edge on the gating channel. See the appropriate section of Chapter 2 for more complete information.

- **Check**

  Check measures the frequency of the counter timebase. The result should always be very close to 10 MHz.

  This function is an excellent diagnostic for the board, since it exercises most of the hardware in the measurement path, as well as the on-board microprocessor and the data path to the host computer.

INPUT CHANNEL SETUP

This menu controlls the setup of the input signal conditioning circuits and the input signal slope selection. See Figure 6.

- **Impedance Hi Lo**

  The channel input impedance can be set to either 1 K-Ohm (Hi) or 50 Ohms (Lo). The selection applies to BOTH channels.

- **Slope Pos Neg**

  Slope selects the input signal edge which is utilized for the measurement. The slope can specify either a rising (Pos) or falling (Neg) edge.

  Slopes are set independently on each channel.

- **Gated Totalize Slopes Start Stop**

  These selections define the gating channel events which start and stop counting for Gated Totalize and Accumulate functions.

- **GT220 In Out Auto**

  These selections control Virtual Front Panel operation when a GT220 1.3 GHz Input Module is connected to the GT200. When a GT220 is not connected "Out" should be selected.

  In Auto mode, the front panel program checks the GTI interface bus for a GT220. **If one is found, it is assumed active and connected to the A input.** Subsequently, all "frequency" type measurements which use the A input are "corrected" for the effects of the GT220 prescaling (i.e. the A input is assumed to be 256 time higher than measured). The correction is applied to Frequency A, Period A, FastFrequency A, Single Period A, Ratio and AutoRatio.

  The In and Out selections allow the user to override automatic GT220 detection. With "In" selected, the Virtual Front Panel corrects functions associated with the A input as detailed above. With "Out" selected, no correction is applied to any measurement.

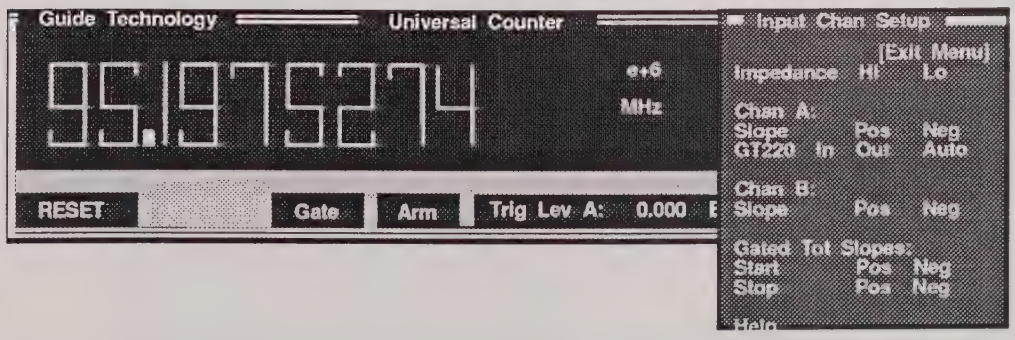


Figure 6. Input Channel Setup Menu

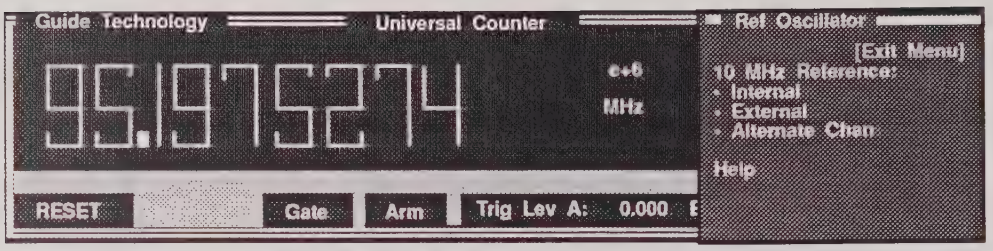


Figure 7. Reference Oscillator Menu

REFERENCE OSCILLATOR

This menu determines the source of the reference signal for the counter. See Figure 7. **Caution: the reference frequency must be within 10% of 10 MHz, or the resolution may be significantly reduced.**

- **Internal**

  Selects the reference oscillator installed on the GT200 board (Either the standard oscillator or the TCXO option).

- **External**

  Selects the signal from the External Arm/External Oscillator input as the reference.

- **Alternate Channel**

  In those functions which require only one active input channel, the second (or alternate) channel can be defined as the reference frequency input. The main input channels provide better signal conditioning than the ARM/OSCILLATOR input.

  The applicable functions are Frequency, FastFrequency, Period, Single Period and Width.

STATISTICS

This menu is used to enable and control several of the GT200 operational modes. See Figure 8.

Statistics Mode

The following menu entries allow selection of two statistics modes or normal operation.

- **Off**

  Acquire and all statistics modes are off. Displayed result is the last measurement made.

- **Continuous Display**

  The selected statistics parameter is computed and displayed as each measurement is made. The result is a "running" calculation of the parameter with the display continually updated.

The number of samples which were used to generate the result is shown below the main display area.

The Continuous mode is especially useful when searching for infrequent error conditions which would generate a "max" or "min" result.

START, STOP and RESET are all active during Continuous mode. RESET is a convenient way to restart the process.

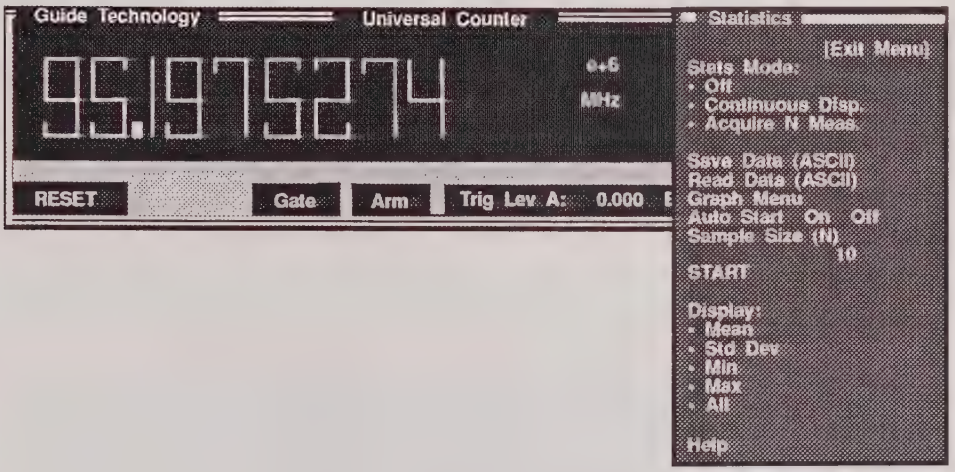


Figure 8. Statistics Menu

- **Acquire N Measurements**

  When the Acquire mode is selected, additional menu items are displayed: these items provide control over measurement operation.

  Acquire mode is used to collect data rapidly or to collect data for statistical computation.

  Auto calibration is turned off during data acquisition to preserve measurement timing and preclude data shifts due to changing cal factors.

  Data collected in Acquire mode can be exported to other programs via a DOS file. See "Save Data", below.

  Pacing will work with Acquire mode, allowing flexible control of the measurement timing.

- **Save Data (ASCII)**

  Data collected in the acquire mode can be saved as an ASCII format DOS file. This feature allows data to be examined, printed, or exported to other programs.

  A dialog box is used to specify a DOS compatible file name. The last file name entered is retained, and can be quickly re-selected by clicking the left mouse button. To safeguard existing data, the program checks to see if the file name is already used. If it does exist, the dialog box requires confirmation before overwriting.

- **Read Data (ASCII)**

  Data in a DOS ASCII file can be imported into the Virtual Front Panel using the Read Data (ASCII) selection. This function allows data previously saved via the Save Data (ASCII) selection to be read and graphed by the VIEWMOD graphing option. Any ASCII file using a compatible format can supply data for importation.

- **Auto Start**

  When Auto Start is Off, a single block of data is acquired and the results displayed. With Auto Start ON, blocks of data are continuously acquired, processed, and displayed.

  Automatic calibration is allowed in the time period between acquisition of data blocks, if Cal is On. See Calibration, below.

  Auto Start allows near real time monitoring of test signal jitter or frequency modulation using the Standard Deviation display.

- **Sample Size**

  Selecting the numeric window portion of this menu item opens a dialog box to allow entry of a new sample size, N.

  N is limited by the amount of available memory in the host computer.

  Pressing any key will abort acquisition, although all data is lost. Common causes for very long acquisition time are: long gate times, long pace times, and auto trigger. Remember it takes up to 0.25 seconds to auto trigger, and this is done on each measurement!

- **START**

  As a convenience, the START button is reproduced in this menu so Acquire mode can be initiated without leaving the menu.

Display

These menu items select the statistics parameter to be shown in the display area. In Acquire mode, the parameter is computed from all measurements in the sample and in Continuous mode, it is computed from the completed measurements.

- **Mean**

  The panel displays the mean value of the measured parameter.

- **Standard Deviation**

  The panel displays the standard deviation of the measured parameter.

- **Minimum**

  The panel displays the minimum value of the measured parameter.

- **Maximum**

  The panel displays the maximum value of the measured parameter.

- **Pk-Pk**

  The panel displays the peak to peak variation of the measured parameter. The value is equivalent to the Maximum minus the Minimum.

- **All**

  Four parameters (Mean, Standard Deviation, Minimum and Maximum) are displayed simultaneously. The display character size is reduced to allow the large number of digits to fit in the display area.

MATH / OTHER

This menu contains miscellaneous functions which give specialized control over operation of the GT200. See Figure 9.

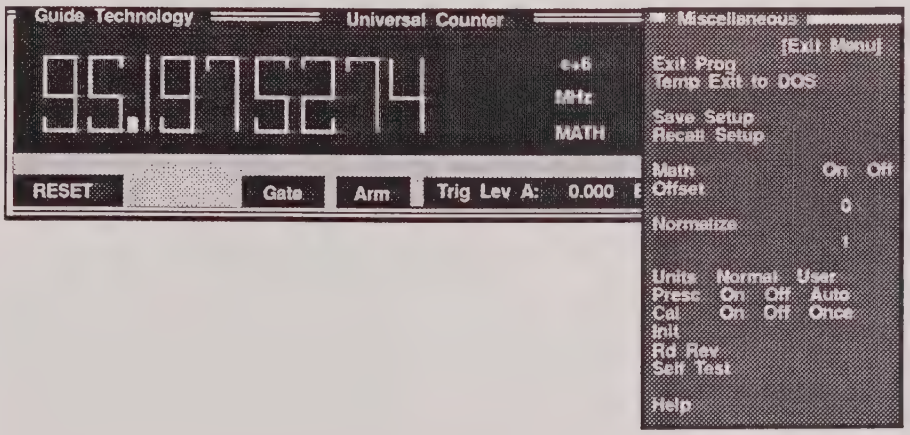


Figure 9. Math/Other Menu

- **Exit Program**

  "Exit Prog" is the correct way to terminate operation of the Virtual Front Panel. This exit ensures that all program details are "cleaned up" before running another application.

  This is NOT the correct way to temporarily return to DOS. All current "acquired" data and setup information will be lost unless they were explicitly saved.

- **Temporary Exit to DOS**

  Provides an easy way to reenter DOS for limited applications. Since the Virtual Front Panel is still loaded, available memory for other applications is reduced. The instrument state is unchanged on return.

  Return to the Virtual Front Panel by entering "exit" at the DOS prompt.

- **Save Setup**

  Saves the CURRENT instrument state to a named file. (measurement data is not saved) When this item is selected, a dialog box is opened for entry of the file name. The last entered name is retained, and can be selected with a click of the left mouse button. Make sure that an important file is not overwritten!

  Any file name acceptable to DOS can be used. A special file, AUTO200.SET, is used to place the Virtual Front Panel in a known state when the program is started. If AUTO200.SET is not found in the current directory, the front panel starts in the "default" state.

  The file name can contain a full DOS path specification, allowing retrieval from any directory.

- **Recall Setup**

  Retrieves a setup from the file named in the associated dialog box.

- **Math On Off**

  Turns both math functions (Offset & Normalize) on or off. When math is enabled (ON), the word "MATH" is displayed on the front panel under the measurement units, to remind users that the display has been manipulated.

- **Offset**

  Opens a dialog box to permit entry of the offset factor. Either fixed or floating point format is acceptable. Examples of numerical entry:

Preferred	Acceptable
-1.00000001e7	-10000000.1
100e-9	+100e-9
	00000100E-00009

  Note that the offset factor is added to the measurement result. To "zero" the display, so that only deviation is reported, use a negative offset. See Chapter 2 for more details on using Math.

- **Normalize**

  Opens a dialog box to permit entry of the normalize factor. Either fixed or floating point format is acceptable.

  See the examples under Offset for acceptable numeric entry formats.

- **User Specified Units**

  This feature allows substitution of three arbitrary characters for the normal units annunciators. User Units can be used in conjunction with offset and normalize to convert transducer data into displays which read directly in temperature, flow rate, or other parameter.

- **Prescaler On Off Auto**

  Three selections allow the high frequency prescaler to be continuously enabled, continuously disabled, or selected automatically.

  The GT200 is usually operated in the Auto mode. See Chapter 2 for more details on choosing one of the alternate selections.

- **Calibration On Off Once**

  Provides control over how often the autocalibration routine is invoked.

  Auto is the normal operating mode. Calibration is performed approximately once every 60 seconds.

  When calibration is turned Off, the current Cal factors are retained. Stable calibration factors preclude a possible shift in results during a period of data collection. Calibration is automatically turned off during Acquire mode.

  Selecting Once causes an immediate calibration procedure, and disables future auto calibration. This mode ensures that data is taken with recent calibration factors, and prevents recalibration from causing a systematic shift in results.

- **Initialize**

  RESETs the GT200 and places it into the default state. See Appendix A for more details on the default state.

- **Read Revision**

  Reads back the GT200 firmware revision and date. Helps ensure that the Virtual Front Panel program is compatible with the board revision.

- **Self Test**

  Invokes the self test normally performed by the GT200 microcomputer on power-up. Useful for diagnostics and troubleshooting.

START / STOP

During some measurement functions and operating modes explicit control of measurement start and stop is provided by this "button", located between the RESET and Gate.

- **START**

  Opens the gate in the manual totalize function and starts acquisition of a block of data in Acquire mode.

- **STOP**

  Closes the gate in manual totalize mode.

CHAPTER 4
CONTROLLING THE GT200 WITH PROGRAM COMMANDS

SYSTEM OPERATION

Many applications for the GT200 require computer control of the board and computer analysis of the measured values. Typical applications range from simple, stand alone, data acquisition systems to complex, multi-instrument, automatic test equipment. User created application programs written in a high level language, such as C, PASCAL, or BASIC, control the system and analyze the data. Application programs are often generated using an integrated programming environment like National Instruments LabWindows.

Application programs normally control the GT200 via a DOS device driver loaded at boot. The device driver receives command strings from the control program through DOS, interprets the strings, and either sends commands to, or reads data from, the counter. After reading data, the driver can immediately pass the results back to the control program or place it in an array in memory (Acquire mode). In some unusual applications, it is preferable to control the board directly through library routines linked to the user program. Linkable library drivers are available for C and Microsoft QuickBasic. See the end of this chapter, or the information files on the Library Disk, for information on controlling the GT200 with the library programs.

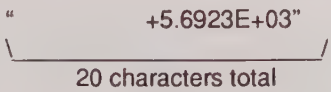
The GT200 device driver and command syntax are compatible with any programming language because the information is transferred using DOS file read and write operations. No matter what language the control program is written in, the driver will see the same information. Programming examples in several languages are included with the distribution diskette which is included with the GT200.

The GT200 command syntax, covered later in this chapter, resembles that used in some advanced GP-IB instruments. The syntax is constructed of English-language-like statements, so it is easy to remember, to use and to debug. No longer does a test engineer need to remember that FU4 is time interval and that FU1 is frequency.

All data passed to and from the driver is in the form of strings. Generally, strings written to the driver are commands, and strings read from the driver are measurement results. For example, the following string would set the counter to the function Ratio A/B with a gate time of 1.125 mS:

"function ratio a/b; gate 1.125e-3"

The data string returned by the driver to the control program after a request for data would look like:



Each programming language has a unique set of key words and requirements to implement file write and read operations. For example, C uses an "fprintf" command to write to a file and an "fgets" to read a file: BASIC uses "PRINT #" and "INPUT #".

In any programming language, the file used to transfer the strings to the driver must be "opened". Details of the file open procedure are language specific and should be covered in the reference manual included with the compiler: some examples, however, are included with the sample programs.

READING FROM THE COUNTER

The counter will always respond to a read operation by returning measurement information, unless the previous command requested another type of data, such as Status or hardware revision number.

The GT200 board is relatively autonomous, and can make measurements without support from the device driver. Normally the counter makes measurements as quickly as it can, immediately starting a new measurement after placing the current results in an output data buffer. This buffer will always contain the most recent measurement data. When the control program requests measurement data, the device driver reads the information contained in the output buffer through the PC I/O bus. This protocol ensures that the device driver will always read the LAST measurement that the GT200 board made. When the driver reads the buffer, a flag is set to ensure that the same information is read only once. If, for some reason, there is no data ready in the output buffer when the driver attempts a read, the system will wait until the measurement is complete. This arrangement ensures that the control program will not return with bogus data or will not have to loop until the data is ready: however, it does mean that a time-out is required to prevent the system from "hanging-up" if there is no input signal to the counter. See the section on the Timeout command.

When the counter board receives a command, it aborts any measurement in progress, clears the output data buffer, and starts a new measurement. Some read commands, such as Read Status, do not change the setup of the counter, and so do not require this procedure (see the specific command descriptions).

The following program fragment shows how the GT200 could be used in a test system to monitor the output frequency of a signal generator. Assume the generator output is connected to the counter input Channel A, and the test requires a 2 second gate time.

```
10    OPEN "GT200$" FOR OUTPUT AS #1
20    OPEN "GT200$" FOR INPUT AS #2
30    ON ERROR GOTO 500
40    REM  Initialize and set up the counter
50    PRINT #1, "INIT; FUNCTION FREQUENCY A; GATE 2"
60    REM  Initialize and set up the function generator
...
200   REM  Set the function generator to 1 MHz
...
300   REM  Wait for function Generator to settle
310   PRINT #1, "WAIT 0.1"
320   REM  Send RESET command to counter to start a new measurement
330   PRINT #1, "RESET"
340   INPUT #2, FREQ
350   PRINT"Actual frequency of generator is ";FREQ
...
500   CLOSE #1
510   CLOSE #2
520   OPEN "GT200$" FOR OUTPUT AS #1
530   OPEN "GT200$" FOR INPUT AS #2
540   PRINT #1, "READ ERROR"
550   INPUT #2, A$
560   PRINT #1, "RESET"
570   PRINT "Error from GT200:  ";A$
580   RESUME NEXT
```

Two techniques are presented in this example which prevent acquisition of incorrect or bogus data. First, a "Wait" is inserted after the signal generator frequency change command to allow stabilization of the output frequency before it is read. The stabilization period can take a second or more, depending on the signal generator and frequency range. The "Wait" command is much easier to implement than a software timing loop.

Because of the long gate time, a read operation performed immediately after the frequency change will likely include pre-change information. Two strategies will guarantee current data: extend the "Wait" to an interval longer than the gate time, or "RESET" the counter after the generator has settled and then perform a read operation. Although the "read" command is sent immediately after the "RESET", the control program will not receive the result until the new measurement is complete, one gate time later.

The same program, written in the C language, can be found in the diskette as GEN.C.

PROGRAMMING COMMANDS

The control program sends all commands to the driver as character strings through DOS file write operations.

- A single string can contain up to 256 characters.
- Individual commands in a string must be separated by the semicolon, carriage return or linefeed delimiters.
- The command string must END with one of the command delimiters. In BASIC, an explicit delimiter is not required, since a carriage return is appended to strings by the PRINT statement.
- Spaces, tabs, and commas may be used as delimiters only WITHIN A COMMAND.

  EXAMPLES:

  ```
  BASIC:   PRINT #1, "fu freq a; gate 0.01"
  C:       fprintf(COUNTER, "fu freq a; gate 0.01\n");
  ```

- A command may be abbreviated for convenience. In the following command summary, the portion printed in capital letters represents the MINIMUM abbreviation: those characters MUST be used.
- The commands are NOT case sensitive, so upper and lower case characters may be mixed freely. The "FUNCTION" command may be typed as "FU", "fu", "Func", or "function".
- Since most of the commands directly correspond to Virtual Front Panel menu choices, commands may be tested before being incorporated into programs.
- Commands can also be tested with a program supplied on the distribution disk, called TRY_CMDS.EXE. The program allows immediate execution of commands entered from the keyboard, so setups and responses can be investigated.
- The numeric entry format is very flexible: it follows standard free format conventions. For example, it will accept either fixed or floating point numbers: the "e" character in floating point notation can be either case. Additionally, if an integer is expected, the driver will accept a floating point number and convert by truncation.

COMMAND DESCRIPTION CONVENTIONS

{ Choice 1 | Choice 2 }	Braces "{ }" indicate that ONE of the items separated by vertical bars MUST be chosen.
[item]	Brackets "[ ]" indicate that the item is OPTIONAL and may be omitted.
< item >	Angled brackets "< >" enclose a variable that must be entered.

LIST OF COMMANDS

Function

FUnction ACCUMulate { A BY B \| B BY A } { POS \| NEG } TO { POS \| NEG }
FUnction AUTORATIO { A/B \| B/A }
FUnction CHECK
FUnction FREQuency { A \| B }
FUnction FASTFREQuency { A \| B }
FUnction PERiod { A \| B }
FUnction RATIO { A/B \| B/A }
FUnction SPERiod { A \| B }
FUnction TIme { A TO B \| B TO A} [DELayed]
FUnction TOTalize { A \| B }
FUnction TOTalize { A BY B \| B BY A } { POS \| NEG } TO { POS \| NEG } [READ ONCE]
FUnction WIDTH { A \| B }

Gate and Trigger

CYCle MODE { NORMal \| SINGLE \| PACEd <seconds> }
GATE <seconds>
PACE START { INTernal \| EXTernal { POS \| NEG }}
TOTalize { START \| STOP }
TRIGger
TRIGger LEVel { A \| B } { <volts> \| AUTO \| HOLD }

Input Setup

IMPedance {HIgh \| LOw }
SLOPE { A \| B } { POS \| NEG }

Arming

DELay <seconds>
ARM SOURCE { EXTernal \| ALTernate \| OFF }
ARM START { POS \| NEG \| OFF }
ARM STOP { POS \| NEG \| OFF }

Read Back

READ (RD) DRVREV
READ (RD) ERRor
READ (RD) HREV
READ (RD) ID
READ (RD) REV
READ (RD) RTCount
READ (RD) SETUP
READ (RD) STATus
READ (RD) STATus STRing
READ (RD) TRIGger LEVel {A | B }

Miscellaneous

ACQuire [<num> <seg> <offs>]
CALibrate { ON | OFF | ONCE }
CLEAR (CLR)
INITialize
OSCillator { INTernal | EXTernal | ALTernate }
PRESCaler { ON | OFF | AUTO }
READY?
RECALL SETUP <#>
RESET (RST)
SAVE SETUP <#>
SELect <#>
TEST
TIMEOUT { <seconds> | OFF }
WAIT <seconds>
WRITE SETUP

COMMAND SYNTAX

This section provides a detailed description of the command syntax used to program the GT200 Universal Counter. The commands are listed in alphabetical order. Each command has the following information (as applicable):

- Command syntax
- Definition of command
- Description of syntax
- Notes (to provide additional information about the command)
- Examples (to clarify a point being made in the "Notes")

ACQuire [<num> <seg> <offs>]

The Acquire function makes a block of measurements at high speed, and places the results directly into the memory of the host computer.

<num> Number of measurements in the block. The maximum number is limited by the amount of memory available. The minimum is 2.

<seg> The segment address of the memory block where the results are placed.

<offs> The offset address of the memory block where the results are placed.

Notes: Each measurement requires 8 bytes of memory. You MUST allocate the memory first and make sure that the memory is available (see the program examples) in the diskette.

Pacing can be used with the Acquire mode to ensure that the data points are made at regular, known, intervals.

The segment and offset numbers are derived from the pointer returned by the memory allocation routine. The diskette contains sample programs that do this.

Take care when specifing measurement setups: inadvertantly leaving auto trigger enabled, or setting a long gate time will generate very long acquisition periods.

Calibration is postponed until the end of the acquisition (see the CALIBRATE command).

If no arguments are specified, the values entered last are used. This feature can speed up your program. For example, the fastest way of making a series of single measurements is to first use the command:

"acq 1 <seg> <offs>" and then use the command:

"acq" to read each subsequent measurement.

The diskette contains program examples that illustrate this.

Example:"acquire 1000 2340 100"

ARM SOURCE { EXTernal | ALTernate | OFF }

Specifies the source of the arming signal:

EXT ARM/OSC input

ALT Alternate Channel. Valid in single-channel measurement (Freq, FastFreq, Per, Sper, and Width)

OFF No arming

Notes: Arming is available in Freq, FastFreq, Per, Ratio, Ti, Ti-Del, Sper, and Width. It is not available in AutoRatio, Totalize, Check, and Accum.

The start arm conditions must also be set, using the ARM START command, or arming will not function. The order of the commands is not important.

When arming is used in conjunction with auto prescaling mode, prescaling is turned OFF, to eliminate any possible ambiguity over the measurement start point. If the input signal frequency exceeds 25 MHz, prescaling MUST be explicitly turned On.

ARM START { POS | NEG | OFF }

Specifies the slope of the arming signal used for start arming.

Notes: Start Arm is available in Freq, FastFreq, Per, Ratio, TI, TI-Del, SPer, and Width.

Start Arm is not available in Tot, Accum, AutoRatio and Check.

The Arm source must also be specified using the ARM SOURCE command. The order of the commands is not important.

ARM STOP { POS | NEG | OFF }

Specifies the slope of the arm signal used to arm the stop.

Notes: Stop Arm is available in TI, SPer, and Width.

Stop Arm is not available in Freq, FastFreq, Per, Ratio, AutoRatio, TI-Del, Tot, Accum and Check.

Stop Arm MUST be used in conjunction with Start Arm.

The Arm source MUST be specified using the ARM SOURCE command. The order of the commands is not important.

CALibrate { ON | OFF | ONCE }

Notes: The counter calibrates itself approximately every 60 seconds if calibration is ON. Two types of calibrations are done—timing skew and interpolator. Time skew calibration is done only in time interval type functions (FastFreq, Ti, Sper, Width), and the interpolator calibration is done in all functions except Ratio, Totalize, and Accum. Skew calibration takes about 25 mS, while the interpolator calibration takes about 1 mS.

When the counter receives the "CAL ONCE" command, it calibrates itself at that time and then turns calibration off. This function allows calibration to be performed at known times, such as before taking a series of high accuracy measurements. It also will prevent calibration in the middle of a critical set of measurements.

In the Acquire mode, the calibration is postponed until the end of the acquisition of a block of measurements.

CLEAR (CLR)

Invokes the same actions as the RESET command.

CYCle MODE { NORMal | SINGLE | PACEd <seconds> }

This command specifies the cycling mode:

NORMAL	Continuously make measurements.
SINGLE	Make only one measurement.
PACED <seconds>	Sets up the counter up to make measurements at time intervals specified by the <seconds> entry.

Notes: In the SINGLE cycle mode, a command such as RESET, can be sent to initiate a new measurement.

The PACED mode allows acquisition of measurements that are evenly spaced in time. See the specifications for the range and accuracy of the pacing interval.

If the pacing interval is less than the measurement time, the counter will simply "skip" measurements. If this occurs during the acquisition of a block of data, a bit is set in the status register, and the warning, "Pace Overrun", appears on the Virtual Front Panel.

Examples:

"cycle mode single"
"cyc mode pace 10.115e-3" (Take a measurement every 10.115 mS)

DELay <seconds>

This command specifies the delay time for Time Interval with Delay function. (see FUNCTION TI-Del command).

Notes: The range for the delay is 20 uS to 3200 Seconds.

Examples:

"Delay 0.52" sets the delay to 0.52 seconds
"del 5.2e-1" same as above
"Del 520E-3" same as above

FUnction ACCUMulate { A BY B | B BY A } { POS | NEG } TO { POS | NEG }

In ACCUMulate, an external signal controls the count gate, rather than software commands. Unlike Gated Totalize, counts may accumulate over multiple gate cycles, controlled by the external gating signal. The signal slopes which open and close the count gate are controlled by required entries in the command syntax. See Chapter 2 for a full description of the function, and the effect that the gating signal slopes have on the gating interval. See also Totalize, and Gated Totalize.

Notes: The RESET command is used to clear the count and close the gate. The next gating signal edge will restart counting.

If the counter is already running when this command is received, counting stops and the count is cleared.

At least 0.5 uS and one cycle of the counted signal must occur between the closing and reopening of the gate.

The GT200 utilizes a unique design which allows the count to be read, without error, even when totalizing at the maximum possible rate. Most other counters can read bogus results unless the gate is closed.

Examples:"fu accum a by b pos to neg"
"Function accumulate b by a pos to pos"

FUnction AUTORATIO { A/B | B/A }

Sets the mode to AutoRatio of A/B or B/A.

Note: If arming is specified, AutoRatio reverts to the regular ratio function.

FUnction CHECK

Sets the mode to Check. Measures the timebase frequency.

Notes: Check is useful as a quick verification of instrument operation. Check can be programmed during the initialization of a control program. The result can be tested automatically, to verify that the counter is healthy. Also see the TEST command.

Uses only the internal oscillator, even if the oscillator selection is Alternate or External.

FUnction FASTFREQuency { A | B }

Sets the mode to FastFreq on either channel A or channel B.

Notes: The gate time setting is ignored in FastFreq.

The actual gate time is 4 signal periods.

Start arming can be used with FastFreq, although Stop arming is not available.

FUnction FREQuency { A | B }

Sets the mode to Frequency on either channel A or channel B.

FUnction PERiod { A | B }

Sets the mode to Period on either channel A or channel B.

FUnction RATIO { A/B | B/A }

Sets the mode to Ratio of A/B or B/A. See Chapter 2 for an operational description of Ratio and recommendations on signal frequencies. Also, see AutoRatio.

FUnction SPERiod { A | B }

Sets the mode to Sper (Single Period).

FUnction TIme { A TO B | B TO A } [DELayed]

This function sets the mode to Time Interval (TI), or if the DELayed option is specified, Time Interval with Delay (TI-Del).

Notes: "DELayed" mode is optional. With the delay selected, stop arm is not available. See Chapter 2 for a description of TI-Del.

The delay time is specified by the DELay command.

Examples: "fu ti a to b"
"Function time A to B delayed"
"fu ti b to a del"

FUnction TOTalize { A | B }

Sets the mode to Totalize. In Totalize, counting is controlled by explicit software commands.

Notes: TOTalize START command opens the count gate and initiates counting.

TOTalize STOP command closes the count gate and terminates counting.

RESET command clears the count.

If the counter is already in the Totalize mode when the TOT command is received, counting stops and the count is cleared.

The GT200 utilizes a unique design which allows the count to be read, without error, even when totalizing at the maximum possible rate. Most other counters can read bogus results unless the gate is closed.

FUnction TOTalize { A BY B | B BY A } { POS | NEG } TO { POS | NEG } [READ ONCE]

This function is usually called Gated Totalize because an external signal controls the count gate. The signal slopes which open and close the count gate are set by the POS/NEG portion of the command (the first specification controls the gate opening and the second controls the gate closing). See Chapter 2 for a full description of the function, and Totalize and Accumulate for related functions.

Notes: Only one measurement, over a single gate interval, is performed. A new measurement will be started when the counter receives most commands. The RESET command is the preferred way to initiate a new measurement.

If the counter is already making a measurement when this command is received, totalization stops and the count is cleared.

READ ONCE is optional, and tells the counter not to output any data until the measurement is done (i.e. the gate is closed). READ ONCE ensures that intermediate data will not be read back to the control program, just the final result. The program will wait during a read operation until the gate closes.

If the READ ONCE option is not used, intermediate results can be read by the control program. In order to identify the final count, READ STATUS must be used to check that the gate has opened and closed.

Examples: "fu tot a by b pos to neg"
"Function totalize b by a neg to neg read once"

FUnction WIDTH { A | B }

Sets the mode to Width (Pulse Width).

GATE <seconds>

The command specifies the gate time for frequency-type measurements (Frequency, Period, Ratio, Check).

Notes: The gate interval in FastFreq is not set by this command.

Examples: "Gate 0.123456"(123.456 mS)
"Gate 123.456e-3"(123.456 mS)

IMPedance { HIgh | LOw }

Selects the input impedance for both channel A and B. HIgh selects 1k Ohm, and LOw selects 50 Ohm.

INITialize

This command initializes the counter to the default state and clears error conditions. See the listing for the default state.

Notes: It is recommended that an INIT be placed at the beginning of all programs, to ensure that the instrument state is known. It is also good practice to send this command to prepare for a totally new setup.

OSCillator { INTernal | EXTernal | ALTernate }

Selects the source of the 10 MHz timebase signal.

INT	Internal timebase
EXT	External Arm/External Oscillator input
ALT	Alternate channel input

Notes: The Alternate selection is valid only for the single-channel measurements Frequency, FastFreq, Period, Sper, and Width.

If Alternate is selected during 2 channel measurements, the oscillator source reverts to the internal timebase.

PACE START { INTernal | EXTernal { POS | NEG } }

Select the source for the trigger signal which initiates pacing.

INT Software triggered. Initiates the first measurement immediately.

EXT The first measurement is delayed until the signal edge specified in the this command is received.

Examples: "pace start int"
"pace start external pos"
"pace start ext neg"

PRESCaler { ON | OFF | AUTO }

This command allows explicit control over prescaling of the input signal used in a measurement. Results are always corrected when the prescaler is in operation.

ONAlways on
OFFAlways off
AUTOAutomatically set according to input frequency. If arming is enabled, the prescaler is turned off.

Notes: Prescaling is necessary when the input frequency exceeds 25 MHz in Frequency, Period, Ratio, and AutoRatio modes (see specifications).

Prescaling does not affect resolution or accuracy in any way.

In AUTO, the counter determines the need for prescaling automatically by making a quick frequency check prior to the actual measurement. The process only takes about 20 uS.

If the input frequency exceeds 25 MHz and arming is enabled, the prescaler must be explicitly turned ON. The Auto prescaler mode reverts to the "OFF" state whenever arming is enabled, to reduce potential measurement start point ambiguity (up to 4 cycles of the input signal may pass before the counter starts).

If the Gate Output signal is being used, see the caution related to the Auto prescale mode.

READ (RD) DRVREV

Reads the revision number of the Device Driver program.

Notes: This command is mainly intended for the Virtual Front Panel program so it can adjust itself to different device driver revs.

Example: Write to counter: "rd drvrev"
Read from counter: " 1.20"

READ (RD) ERRor

Read the error number and message from the counter.

Notes: After sending this command, the next string returned to the control program by a file read is the error number and message.

Errors are cleared only by the INIT and RESET commands.

See the programming examples elsewhere in the manual and on the diskette.

Examples: Write to counter:"rd error"
Read from counter:"101 Command syntax"

READ (RD) HREV

Reads the hardware revision of the GT200 board (usually a single letter).

Notes: This command is mainly intended for the Virtual Front Panel program so it can adjust itself to different board revs.

Example: Write to counter:"rd hrev"
Read from counter:"C"

READ (RD) ID

Reads the ID code of the board (usually a number). The code for the GT200 is "1".

Notes: This command is mainly intended for the Virtual Front Panel program so it can detect the kind of instrument installed.

Example: Write to counter:"rd id"
Read from counter:"1"

READ (RD) REV

Read the software revision of the board including time and date information.

Notes: This command is mainly intended for the Virtual Front Panel program so it can adjust itself to different firmware revs.

Example: Write to counter:"rd rev"
Read from counter:" 1.00 4/17/89 11:23"

READ (RD) RTCount

Read the "real time" count from the counter.

Notes: This command returns the number of seconds since the computer was turned on, as a floating point number with a resolution of 1 uS.

The counter overflows after about 6 years.

This command can be used to implement time delays in application programs, or to measure the execution time of various parts of a program.

See also the WAIT command.

Example: Write to counter:"rd rtc"
Read from counter:" +2.123456789E+03" (35 min., 23.456 seconds)

READ (RD) SETUP

This command returns a string which represents the complete setup of the counter. You may save the string in your program or in a file, and then write it back to the counter using the WRITE SETUP command. The string is about 50 bytes long, but you should allow for 256 bytes.

Notes: READ and WRITE SETUP are complimentary functions. They should not be confused with the SAVE AND RECALL SETUP functions.

Example: Write to counter: "rd setup"
Read from counter:" x123456789012345689ABCDEF.... "

READ (RD) STATus

Read the status of the counter. The status bits are defined as follows:

Bit#	Hex Value	Decimal Value	
15	8000	32768	Reserved
14	4000	16384	Reserved
13	2000	8192	Reserved
12	1000	4096	Reserved
11	0800	2048	Reserved
10	0400	1024	Reserved
9	0200	512	Reserved
8	0100	256	ODR—Output Data Ready. The output buffer has measurement data or other data that you requested ready to be read by your program. You can check this bit before reading measurements to ensure that your program will never wait for data.
7	0080	128	ERR—An error has occurred. You can read the error code and message with the READ ERROR command. The error is cleared only with the RESET or the INIT commands.
6	0040	64	Reserved
5	0020	32	POV--Pace Overrun Warning. A Pacing Overrun occurs when a paced measurement does not complete soon enough to allow the next scheduled measurement to start on time. Skipping of measurements will occur, which may be of concern if it is necessary to know exactly when each data point was taken.

4	0010	16	GTD—Gated Totalize measurement is Done.
3	0008	8	TLB—Trigger Level B is settled. See the description for the A channel.
2	0004	4	TLA—Trigger Level A is settled. This is useful for making sure that the trigger level is already determined by the auto trigger before using the Hold option or reading out the trigger levels.
1	0002	2	ARM—waiting for arm signal. High when arming is used, and the counter is waiting for an arming signal to start or to end the measurement. It is also high during the delay in the Time Interval with Delay mode. This is the bit used by the front panel program for the Arm indicator.
0	0001	1	GAT—Gate is open. This is the bit used by the front panel program for the Gate indicator.

Notes: After sending this command, the next string read is the status as a decimal integer string that ranges from 0 to 65535.

To determine if a bit is set, you need to "mask" it by using the AND operator in the specific language used. See the programming examples on the diskette.

You can read the status anytime without disturbing the measurement in progress or the measurement data.

Example: Write to counter:"rd stat"
Read from counter:"269" (256 + 8 + 4 + 1)

READ (RD) STATus STRing

This command returns the same status as the READ STATUS command, except that it translates it to a 64 character string as follows:

Every bit of the 16 bits in the status word is translated into a three character name and a space. If the bit is true (a "1"), its name will be in capital letters. The reserved bits are represented by spaces

Example: If the status word is 259 (256 + 2 + 1), which corresponds to the Output Data Ready bit, plus the Waiting for Arm bit, plus the Gate Open bit, the returned string would be as shown below.

Write to counter:"rd stat str"
Read from counter:
" ODR err pov gtd tlb tla ARM GAT"
_____/
64 characters

READ (RD) TRIGger LEVel { A | B }

This command allows the control program to determine what level has been chosen by the auto trigger function on the specified channel.

Write to counter:"rd trig lev a"
Read from counter:" +1.250"

Notes: Normally the counter returns the last setting made by the auto trigger function. If auto trigger was recently switched on, it may take as long as 250 mS before the data is ready. The control program can find out if trigger levels are settled with the READ STATUS command, or a measurement read can be made. The data will only be returned after the auto trigger is settled and a measurement made.

The number returned will always have 3 digits after the decimal. Spaces are added at the beginning of the string to make it 8 bytes long.

READY?

The counter returns a "1" if there is data to read, and a "0" otherwise. This is a convenient way of getting the state of the Output Data Ready bit of the status word (see READ STATUS).

Write to counter:"ready?"
Read from counter:"1"

RECALL SETUP <#>

Recall the specified setup that was saved with the SAVE SETUP command. The SAVE and RECALL command pair operate on instrument setups stored in the driver memory (they are lost at power down). The benefit is speed: in a long test program, the lengthy command string must only be sent to the board once (e.g. by the WRITE SETUP command). It can be SAVEd and RECALLed thereafter.

Notes: The GT200 setup information will be saved in the driver with the SAVE SETUP command. The setup information is a complete description of the instrument state.

Up to 10 setups (numbered 1 through 10) can be SAVEd and RECALLed.

Example: "save setup 5"
"recall setup 5"

RESET (RST)

Resets the counter (does not change any setups).

Notes: This command clears the output data buffer, starts a new measurement, clears the count in Totalize and Accumulate, and clears errors.

The setup of the instrument is not changed.

SAVE SETUP <#>

Saves the current instrument setup for later Recall. See the RECALL SETUP command. The setup is saved in the driver memory and cannot be read out.

SELect <#>

Selects the specified counter board when multiple boards reside in the host computer.

Notes: The device driver can control multiple GT200 counters. Select informs the software which board should be used next.

The boards are numbered beginning with 0. Board number 0 has the lowest I/O address (see Installation Instructions).

If only one GT200 board is installed in the computer, this command is not needed.

Example:"select 0"(Selects the board with the lowest address)

SLOPE { A | B } { POS | NEG }

Selects the input signal slope (edge), for the specified channel, which will be used in a measurement.

Example: "slope a neg"

TEST

Instructs the GT200 board to perform a self test.

Notes: The counter does a test of the EPROM on the board, the internal RAM in the microprocessor, and a few other checks. This test takes about 60 mS. A READ ERROR command will then report if any errors were found.

Every time you turn on your computer, or reboot, a more extensive self test is performed automatically.

Example: Write to counter: "test; rd error"
Read from counter: "0 No error"

TIMEOUT { <seconds> | OFF }

Sets the maximum time allowable for a measurement read operation. In most measurement functions, the GT200 will wait indefinitely for a measurement to end if the input signal is removed or changes amplitude. If an attempt is made to read data from the board under this condition, the host computer will wait until the data is available. This lock-up situation can be avoided by programming the timeout to an interval which is longer than any expected measurement, but will still allow the program to regain control if there is a signal fault.

Notes: If a timeout error occurs, no data is returned to the control program.

The purpose of the timeout is to prevent system hang-ups on fault conditions, such as an input signal which is too low in frequency or is not present due to a fault.

The range for the timeout is 0.01 to 3200 seconds.

Some measurements can be expected to take a long time: e.g. measurements with long gate times or using low frequency input signals. If there is a potential problem, the READY? or READ STATUS commands can be used to see if data is ready and avoid unnecessary timeouts.

See the program examples on the Distribution diskette for the use of Timeout.

Example: "timeout 20"

TOTalize { START | STOP }

The control program statements which provide start and stop control for Totalize Mode (i.e. open and close the count gate).

TRIGger

Clears the data from the previous measurement and starts a new measurement.

TRIGger LEVel { A | B } { <volts> | AUTO | HOLD }

Sets the trigger level for the specified channel.

<volts> Sets a fixed level. Range +5.000 V to -5.000 V. The setting is rounded to the nearest 0.04 V.
AUTO The GT200 automatically sets the trigger level on the specified channel.
HOLD Holds the current trigger level.

Notes: Auto-trigger is performed before every measurement and may take as long as 250 mS or as little as 50 mS.

If the input signal amplitude is stable, auto trigger can be used to set an appropriate trigger level, and then HOLD can be invoked to maintain that level. The succeeding measurements can be performed more rapidly with auto trigger off. Before the hold mode is invoked, the status should be checked to ensure that auto trigger has finished the level setting procedure. Alternatively, a measurement read can be performed: the data will only be returned after the auto trigger (and the measurement) has completed.

Examples: "Trigger level a 2.11"
"trig lev a -0.23"
"TRIG LEV B AUTO"

WAIT <seconds>

Time delay for use by your program.

Notes: When this command is sent, the counter waits for the time specified before returning to the control program. WAIT is useful for producing accurate delays in programs, since DOS does not have good timing facilities. Specifically, the clock can be read with a 10 mS resolution from DOS, but only in a format that is difficult to use; accuracy is also only 50 mS.

The WAIT command provides an easy method of halting execution while relays close, function generators settle, etc.

The actual delay is the time specified, plus some "overhead" (the time spent sending the command through DOS, etc.), which on an 80286 based host computer is a few mS. Therefore, even a 0 wait interval will require a few milliseconds to process.
The range of time allowed is 0 to 3200 seconds.

Long time delays can sometimes be utilized by the host computer for other tasks. The control program can implement its own wait utility, using the READ RTCOUNT command to determine when the wait started, and how much time has elapsed.

Example: "wait 0.2" (0.2 seconds)
"wait 200e-3" (0.2 seconds)
"wait 5e-3" (5ms, typical for relays)

WRITE SETUP

This command is used to send the counter a setup string read out with the READ SETUP command.

Example: Write to counter: "write setup x123456789012345689ABCDEF.... "

LabWindows INSTRUMENT MODULE

The LabWindows instrument module for the GT200 is included on a disk, sent with the instrument, in subdirectory "LW". The National Instruments programming environment simplifies control of GPIB and PC resident instruments, such as the GT200, by standardizing menus and function panels, in addition to providing an easy way to generate C and BASIC programs.

The Instrument Module on this diskette is for LabWindows rev 1.2 only. For an Instrument Module compatible with rev 1.1, please contact Guide Technology. LabWindows is available from Guide Technology or from National Instruments.

GT200 C LIBRARY FUNCTIONS

The GT200 is supplied with a driver suitable for linking with Microsoft C programs (large model only), or with assembly language programs: the linkable driver is located on the distribution disk in subdirectory "C_DRV". Linking the driver to application programs is an alternative to using the DOS Installable Device Driver (declared in the CONFIG.SYS file). The linkable driver provides a significant speed advantage because the application program does not have to go through DOS to communicate with the counter board.

Note that a C program utilizing the linkable driver MUST BE LARGE MODEL ONLY.

The following files are included in this directory:

GTMSCL.LIB	The library.
LNK_PROG.C	Example C program.
LNK_PROG.OBJ	Object code of example C program.
LNK_PROG.EXE	Executable code of example C program.

The library contains 9 routines that can be called from an application program. Three of the routines simulate the DOS Installable Device Driver:

init_gt200 — Performs the operations that are normally done by the Installable Device Driver at boot time. YOU MUST CALL THIS ROUTINE BEFORE CALLING ANY OTHER.

rd_gt200 — Reads a string from the board.

wr_gt200 — Writes a string to the board.

Complete programs can be written using only the above 3 routines, since all commands can be sent with the wr_gt200 routine, and all responses from the board may be read back in string form with the rd_gt200 routines. However, even faster operation is possible if the following 6 routines are used to minimize string operations in the interface between driver and program.

rd_dbl_gt200 Equivalent to rd_gt200, but reads MEASUREMENT DATA ONLY in floating point form (8-byte double).

rd_rtc_gt200 Reads the real time clock in the board.

rd_stat_gt200 Reads the status word from the board (useful for checking if measurement is completed).

ready_gt200 Checks availability of measurement data (See caution note in description of rou tine).

reset_gt200 Sends RESET command to the board (useful for starting a new measurement).

select_gt200 Sends the SELECT command to specify the active board (only needed if multiple boards are present in the system).

List of C Library Routines

- int init_gt200(base_addr,num);

  int base_addr; Base address of boards.
  int num; Number of boards installed.

  Return value: Error code.

  Notes: YOU MUST HAVE A CALL TO init_gt200 BEFORE CALLING ANY OF THE OTHER ROUTINES.

- int wr_gt200(str);

  char * str; Command string to write to counter

  Return value: Error code.

- int rd_gt200(str);

  char * str; Destination string for data from counter. String shoud be 256 bytes.

  Return value: Error code.

- int rd_dbl_gt200(meas);

  double * meas; Pointer to double for measurement.

  Return value: Error code.

  Notes: This routine is much faster than rd_gt200 since there is no conversion of the result to a string. The data is returned already formatted as a double. The only information lost is the number of significant digits in the result.

- int rd_rtc_gt200(tim);

  double * tim; Pointer to double for time in seconds.

  Return value: Error code.

  Notes: Equivalent to wr_gt200("rd rtc") followed by rd_gt200(), for reading the real time clock in the board.

- int rd_stat_gt200(stat_word);

  int * stat_word; Pointer to integer for status word.

  Return value: Error code.

  Notes: Equivalent to wr_gt200("rd stat") followed by rd_gt200(), for reading the status word from the board. The status word includes a bit for "OUTPUT DATA READY"

- int ready_gt200();

  Return value: 1 if a measurement is ready, 0 otherwise. See CAUTION below.

  Notes: Equivalent to wr_gt200("ready?") followed by rd_gt200(), for checking if the board has data for output.

  CAUTION: Sometimes the routine returns a "0", even though data is actually available. This can happen when there is data in the buffer which has not been read out, and a new measurement has just completed. The board clears this bit while replacing the data in the buffer in order to prevent reading of the buffer while the data is changing: this process takes about 30 us. Calling this routine a second time, after a delay of 30 uS, will return the correct response.

  You may unambiguously determine data availability using the rd_stat_gt200() routine. However, rd_stat_gt200() is substantially slower than ready_gt200(). (See the speed table below).

- int reset_gt200();

  Return value: Error code.

  Notes: Equivalent to wr_gt200("rst").

- int select_gt200(board_num);

  int board_num; Number of board to select (starting from 0)

  Return value: Error code.

  Notes: Equivalent to wr_gt200("select board_num").

Execution Speed

The table below shows the typical execution times for some of the routines using a 10 MHz "AT" class machine (80286), with a math co-processor (80287).

Routine	Execution Time (in uS)
wr_gt200	Depends on string sent
rd_gt200	Depends on data (several mS for measurements)
rd_dbl_gt200	850
rd_rtc_gt200	350 to 700
rd_stat_gt200	450
ready_gt200	15
reset_gt200	1850
select_gt200	35

Compiling With the GT200 Library

To link programs with the library, the library file GTMSCL.LIB must be specified in the link command. The Microsoft C "cl" command, might look like this:

```
cl /AL my_prog.c gtmscl.lib
```

Using the Library From Assembly Language Programs

To use the GT200 Library with an assembly language program, please refer to the "Mixed Language Programming Guide" in the Microsoft C 5.1 manual. Although the routines supplied in this section look like C routines, they do not require the initialization code mentioned in the Microsoft manual. Only the interface is the same as C routines. Note that when calling these routines from assembly language, their name is changed by preceding it with an underbar. For example:

```
_init_gt200
_wr_gt200
_rd_gt200
_rd_dbl_gt200
_rd_rtc_gt200
_rd_stat_gt200
_ready_gt200
_reset_gt200
_select_gt200
```

Also, the library was assembled with the /MX and /ML options of the Microsoft Macro Assembler, which preserves case sensitivity.

CHAPTER 5
APPLICATIONS

HIGH SPEED DATA ACQUISITION USING THE GT200

ACQUIRE MODE

There are two basic methods of reading GT200 measurement data, file read and Acquire. A DOS file read is the most straight forward procedure, but is relatively slow because the device driver must process the request for data, read the data from the board, convert it to a decimal ASCII string, and then send it back through DOS to the application program. For example, a 10 MHz "AT" requires 600 uS PER CHARACTER just to transfer the string from the device driver to the application program. Since each measurement string is 20 characters long, it takes over 12 mS to transfer the result of one measurement!

Acquire mode is a substantially faster procedure for reading measurement results from the GT200, especially when large blocks of data are required. Higher speed is possible because most of the DOS data transfer overhead is eliminated. In Acquire mode, the application program sends the ACQUIRE command to the driver, along with the number of measurements desired and the destination address for the data. The device driver reads the specified number of measurements from the board and places them directly in the host computer memory, starting at the address specified. After all the measurements are taken, the driver computes and calibrates the results, and then returns control to the application program. From the user's perspective, the measurement data simply "appears" in the specified array. See the example programs "FASTMEAS.C" and "ACQUIRE.C" on the distribution disk.

PACING

The pacing capability of the GT200 should not be confused with the acquire mode. Pacing simply schedules measurements, ensuring that they are taken at a specific rate; each measurement is started one pacing interval after the enabling of the last measurement. Pacing is useful with BOTH methods of reading data, but for short pacing intervals, the acquire mode must be used.

Generation of the pacing interval is performed on the GT200 board, by the same microprocessor that controlls the measurement. This additional overhead reduces the maximum measurement rate available. If a higher rate is needed, pacing can be emulated by arming the GT200 from an external source. The maximum measurement rate with arming, can be derived from the "Max meas cycle time" column, in the table below. Note that this time is typically 200 uS less than the minimum pacing interval.

LINKABLE DRIVER

Another option for increasing the measurement rate is the linkable driver. This alternative allows an application program, written in C, direct access to the GT200, eliminating delays due to DOS. For more information, see page 4-22.

Measurement Speed Table

In the table below:

1. All the times are in uS.

2. "MT" stands for actual measuremnt time, which, for frequency-type functions, is the total time the gate is open (gate time plus up to one signal period). For time-interval type functions "MT" is the measured interval.

3. The times assume that Auto-trigger is off.

Functions	Measurement Times	Avg. meas. cycle time	Max meas. cycle time	Min pacing interval
Freq, Per, Check	MT = 250 uS MT > 500 uS	700 MT + 350	800 MT + 400	1000 MT + 600
Ratio	MT = 250 uS MT > 500 uS	550 MT + 200	650 MT + 200	850 MT + 400
TI, TI-Del, Sper, Width, FastFreq	MT < 50 uS 50 uS < MT < 1 mS MT > 1 mS	450 MT + 450 MT + 300	550 MT + 550 MT + 350	800 MT + 750 MT + 600

SEE PAGE 4-25 FOR SPEED INFORMATION WHEN THE **LINKABLE DRIVER** IS USED.

APPENDIX A

DEFAULT SETUP SPECIFICATION

This is the setup after power up (or reboot), and after you send the INIT command:

Function	Frequency A
Gate Time	300 mS
Trigger Levels	Auto
Cycle Mode	Normal
Pace Time	1 S
Impedance	High
Slopes	Pos
Arm Source	Off
Arm Start	Off
Arm Stop	Off
Delay	1 mS
Calibration	On
Oscillator	Internal
Pace Start	Internal
Prescaler	Auto
Timeout	Off
Gt220	Auto

APPENDIX B

ERROR CODES

The following is a list of the error codes and the conditions that cause them. Error numbers 1 to 99 originate from the GT200 itself, while the numbers 100 to 199 are from the Device Driver which resides in the PC.

0 -- No error

1 -- Data framing error in the communication between the Device Driver and the GT200. This may occur when you use an address for the GT200 which is in conflict with some other board.

2 -- Handshake timeout in the communication between the Device Driver and the GT200. This may occur when you use an address for the GT200 which is in conflict with some other board, or if the GT200 is not installed.

3 -- Invalid range of data in command.

4 -- Invalid function # (in the Function command).

5 -- Measurement did not terminate during calibration -- hardware failure.

6 -- Start interpolator calibration got neg # -- hardware failure.

7 -- Stop interpolator calibration got neg # -- hardware failure.

8 -- Start interpolator timeout -- hardware failure.

9 -- Stop interpolator timeout -- hardware failure.

10 -- No oscillator -- There is no 10 MHz reference timebase. Usually this occurs when you select ALT or EXT oscillator, but do not supply a 10 MHz signal to the appropriate input.

11 -- Invalid command received.

12 -- Invalid function number (in the Function command).

13 -- Measurement overflow.

14 -- Skew calibration -- hardware failure.

15 -- Totalize -- hardware failure.

16 -- Totalize overflow.

17 -- ROM test error during self test.

18 -- RAM test error during self test.

19 -- Skew calibration -- hardware failure.

20 -- Skew calibration -- hardware failure.

21 -- Skew calibration -- hardware failure.

101 -- Command syntax error.

102 -- Parameter range error.

103 - Handshake timeout in the communication between the Device Driver and the GT200. This may occur when you use an address for the GT200 which is in conflict with some other board, or if the GT200 is not installed.

104 - Handshake timeout in the communication between the Device Driver and the GT200. This may occur when you use an address for the GT200 which is in conflict with some other board, or if the GT200 is not installed.

105 - Board not found.

106 - Remote input required for this command.

107 - Input string is too long.

108 - Command is too long.

109 - Unrecognized word.

110 - Unrecognized command.

111 - Not enough arguments in command.

112 - Too many arguments in command.

113 -- Communication error with the board. This may occur when you use an address for the GT200 which is in conflict with some other board, or if the GT200 is not installed.

114 -- Communication error with the board. This may occur when you use an address for the GT200 which is in conflict with some other board, or if the GT200 is not installed.

115 -- Communication with the board was aborted.

116 -- User-specified timeout on measurement.

117 -- Calculation error -- The data received from the board was probably bad.

118 -- Bad data from board.

119 -- Bad data from board.

120 -- Handshake timeout in the communication between the Device Driver and the GT200. This may occur when you use an address for the GT200 which is in conflict with some other board, or if the GT200 is not installed.

121 -- User-aborted measurement.

122 -- Data communication error between the Device Driver and the board.

123 -- Data communication error between the Device Driver and the board.

124 -- Handshake timeout in the communication between the Device Driver and the GT200. This may occur when you use an address for the GT200 which is in conflict with some other board, or if the GT200 is not installed.

APPENDIX C

GUIDE TECHNOLOGY LIMITED WARRANTY

LIMITED WARRANTY AND DISCLAIMER

Guide Technology, Inc. (GTI) warrants that, for a period of twelve (12) months from the date of delivery to you, as evidenced by your receipt, order acknowledgment or invoice, the GT200 (the Product) will be free from defects in materials and workmanship. Product specifications are defined by Manufacturer's test procedures and techniques.

GTI's entire liability and your exclusive remedy under this warranty (which is subject to you returning the Product to GTI) will be, at GTI's option, (1) to (a) attempt to correct or help you work around defects that are described by you in writing in sufficient detail for GTI to reproduce them on GTI's premises in combination with equipment reasonably designated by GTI and/or (b) provide you with a reasonable amount of telephone consultation from GTI's premises during GTI's normal business hours, (2) to repair or replace the Product or software with functionally equivalent products, or (3) to refund the purchase price.

EXCEPT FOR THE ABOVE EXPRESS LIMITED WARRANTIES, GTI MAKES, AND YOU RECEIVE NO WARRANTIES, EXPRESS, IMPLIED, STATUTORY, OR IN ANY COMMUNICATION WITH YOU, AND GTI SPECIFICALLY DISCLAIMS ANY IMPLIED WARRANT OR MERCHANTABILITY OR FITNESS FOR A PARTICULAR PURPOSE. GTI does not warrant that the operation of the Product will be uninterrupted or error free, and GTI will have no responsibility for errors or defects due to limitations on the equipment on which the Product runs.

BY USING THE PRODUCT, YOU AGREE THAT IN NO EVENT WILL GTI BE LIABLE FOR ANY DAMAGES, INCLUDING LOSS OF DATA, LOST PROFITS, COST OF COVER OR OTHER SPECIAL, INCIDENTAL, CONSEQUENTIAL OR INDIRECT DAMAGES ARISING FROM THE USE OF THE PRODUCT, HOWEVER CAUSED AND ON ANY THEORY OF LIABILITY. THIS LIMITATION WILL APPLY EVEN IF GTI HAS BEEN ADVISED OF THE POSSIBILITY OF SUCH DAMAGE. YOU ACKNOWLEDGE THAT THE PURCHASE PRICE OF THE PRODUCT REFLECTS THIS ALLOCATION OF RISK.

APPENDIX D

SPECIFICATIONS

INPUT CHARACTERISTICS

Channels A and B

- Frequency Range: DC to 100 MHz
- Signal Operating Range: +5 V to -5 V
- Coupling: DC
- Sensitivity:
  - Sinewave: 25 mV rms DC to 20 MHz
    50 mV rms 20 MHz to 50 MHz
    160 mV rms 50 MHz to 100 MHz
  - Pulse: 450 mV pk-pk at 5 ns pulse width
- Impedance: Software selectable, 1K Ohm ± 30 pf or 50 Ohm
- Trigger (Threshold) Level: (Set by software command or auto trigger)
  - Range: ±5.00 V in 40 mV steps
  - Accuracy: ±3% of setting ± 0.04 V
- Auto Trigger: Automatic selection of optimum trigger level.
  - Signal repetition rate: 100 Hz to 75 MHz
  - Minimum signal amplitude: 1.3 x Sensitivity
- Maximum Signal Input:
  - 1k Ohm: 15 V rms (DC to 1 MHz), 5 V rms (above 1 MHz)
  - 50 Ohm: 5 V rms

Arm/Oscillator Input

- Impedance: >500 Ohms
- Maximum Input Voltage: 15 V rms
- When Used as 10 MHz Oscillator Input:
  - Sensitivity: 150 mV rms sinewave: 450 mV pk-pk pulse
  - Duty ratio: 40% to 60%
  - Coupling: AC
- When Used as Arm Input: TTL Compatible
  - Sensitivity: 300 mV pk-pk around fixed +1.4 V threshold
  - Coupling: DC
  - Minimum pulse width: 15 ns

MEASUREMENT FUNCTIONS

Frequency A or B

- Range: DC to 100 MHz
- Gate Time: 250 us to 3200 seconds (plus up to one signal period)
- Significant Digits and LSD:
  - The number of significant digits is approximately 10 per second of Gate Time, e.g., 7 digits in 1 ms.
    LSD = Freq. x 100 ps / Gate Time
- Resolution: (in Hertz)
  ± LSD ± Freq. x (300 ps rms + [1.4 x Trigger Error]) / Gate Time
- Accuracy: (in Hertz)
  ± Resolution ± Time Base Error

Fast Frequency A or B

- Range: DC to 100 MHz
- Gate Time: 4 signal periods, fixed
- Accuracy: (in Hertz)
  ± Freq. x (500 ps + 300 ps rms + [1.4 x Trigger Error]) / Gate Time
  ± Time Base Error

Time Interval A to B or Time Interval B to A

- Range: -1 ns to 100,000 s (> 25 hr)
- Least Significant Digit (LSD): 100 ps
- Resolution:
  ± LSD ± 300 ps rms ± Start Trigger Error ± Stop Trigger Error
- Accuracy:
  ± Resolution ± Time Base Error ± Trigger Level Timing Error ± 2 ns
- Delay: Stop events will be ignored for a programmable period of time following the start event. Range: 20 us to 3200 s
- Minimum Pulse Width: 8 ns

Totalize and Gated Totalize, A or B

- Control: Count gate can be controlled by program statement, keyboard input, or by events on the second input channel (Gated Totalize). In Gated Totalize, start and stop event slopes are selectable.
- Rate: DC to 25 MHz. 20 ns minimum pulse width.
- Modes: Single – Count is reset before every gate open.
  Accumulative – Count is totalized over multiple start-stop sequences.
- Range: 0 to 2.8×10^{14} counts
- Accuracy: ±1 count

Period A or B (Single Period)

- Range: 25 ns to 100,000 s
- See "Time Interval" for Resolution and Accuracy

Period A or B (Multiple Period Average)

- See "Frequency" for Range and Gate Time.
- LSD: Period x 100 ps / Gate Time
- Resolution:
  ± LSD ± ([1.4 x Trigger Error] + 300 ps rms) x Period / Gate Time
- Accuracy: ± Resolution ± Time Base Error

Ratio A/B or B/A

- Gate Time: 250 us to 3200 s
- Range: DC to 100 MHz on either input. DC to 25 MHz on second input.
- LSD: Ratio/[$FREQ_{hi}$ x Gate Time] $FREQ_{hi}$ = higher frequency input
- Resolution and Accuracy:
  ± Ratio x [$FREQ_{low}$ Trigger Error] / Gate Time ± LSD
  ($FREQ_{low}$ = lower frequency input)

Width A or B

- Accuracy: Same as Time Interval, plus 5 ns

Pacer

- Automatically initiates measurements at user specified time intervals:
  Interval = 0.8 ms to 3200 seconds

GENERAL

Compatibility

- Takes 1 full size slot in any PC/XT, PC/AT or compatible, using DOS 3.0 or higher. Software compatible with any programming language.

Measurement Rate (Maximum)

- For a Block of Measurements (any PC)
  - 2300/sec for time and Fast Frequency modes
  - 1400/sec for frequency and period modes
  - Block size is limited only by computer memory
- For a Single Measurement (12 MHz "AT")
  - 1000/sec for all modes

Signal Slope

- Programmable on Channel A, Channel B, Arm Start, and Arm Stop.

Arming

- Available on all modes, except Totalize
- Arm Setup Time: Minimum 40 ns before selected event

Time Base

- Standard: 10 MHz Crystal Oscillator
  - Temperature: ±5 ppm, 0° to 40° Celsius
  - Aging: < 2 ppm/yr or < 2×10^{-7}/mth
  - Supply Voltage: < 1×10^{-8} for 10% change
  - Short Term: < 5×10^{-10} rms with a 1 second averaging time
- Option 10: 10 MHz TCXO
  - Temperature: ±1 ppm, 0° to 40° Celsius
  - Aging: < 1 ppm/yr or < 1×10^{-7}/mth
  - Supply Voltage: < 1×10^{-9} for 10% change
  - Short Term: < 2×10^{-10} rms with a 1 second averaging time
- Option 20: 10 MHz Ovenized Oscillator (GT300 module)
  - Temperature: ± 1×10^{-8}, 0° to 40° Celsius
  - Aging: < 5×10^{-10}/day
  - Supply Voltage: < 1×10^{-10} for a 10% change
  - Short Term: < 1×10^{-10} rms with a 1 second averaging time

External Reference (10 MHz)

- Input: Arm/Oscillator. Alternatively, the second signal input may be defined as the reference, in Frequency and Period modes.

Power Requirements (typical from computer)

+5 V @ 0.8 Amp	-5 V @ 0.05 Amp
+12 V @ 0.2 Amp	-12 V @ 0.02 Amp

Supplemental Definitions

- Trigger Error: Error due to noise superimposed on the input signal from both internal and external sources.

$$\text{Error} = \frac{\sqrt{500\mu V^2 + E_n^2}}{\text{(input signal slew rate)}} \text{ seconds rms}$$

  E_n = rms noise of input signal (100 MHz Bandwidth)
- Trigger Level Timing Error: Time measurement inaccuracy due to threshold uncertainty.
  < 250 mV / (input signal slew rate)
- Time Base Error: Fractional frequency deviation of reference signal from 10 MHz due to all error components, times the measurement results.

Specifications subject to change without notice.

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